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Research Reports

absorption of **f**at

in various

NUTRITIONAL & ENVIRONMENTAL STATES

by DR. I. L. CHAIKOFF

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absorption of fat in various nutritional and environmental states

A BIBLIOGRAPHY AND REVIEW OF THE LITERATURE

by Dr. I. L. CHAIKOFF

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This annotated bibliography and critical appraisal of the literature on fat absorption was undertaken in cooperation with the Committee on Food Research of the Quartermaster Food and Container Institute for the Armed Forces. It should not be inferred that the War Department endorses the views presented, the conclusions drawn, or any evaluations of products or processes that may appear herein. In the interests of untrammelled research, it is necessary to assign to the authors complete responsibility for the interpretation of their data.

Approved for publication

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I. INTRODUCTION

BIBLIOGRAPHY OF FAT ABSORPTION

INTRODUCTION

This bibliography has been prepared in order to present the status of our knowledge on a subject which at present seems poorly understood. In a recent speech Professor C. H. Best stated: "It is high time that a vigorous new study utilizing the modern methods of fat estimation and identification should be made upon the process of absorption of fat from the intestines."*

Notwithstanding the hundreds of publications, most of the fundamental problems on absorption remain unsolved. It is difficult to compare the data of different laboratories for two reasons. First of all, the choice of the animal seems an important factor and care should be exercised in comparing results obtained on different species. Secondly, different methods of investigation have been in use, each one presenting its own problem of interpretation. It seems justified, therefore, to enumerate some of the most widely used experimental methods and to point out their limitations for the study of fat absorption.

1) HISTOLOGICAL METHODS:

These procedures are concerned mainly with the appearance of the intestinal cells during fat absorption. Obviously the results obtained by these methods are only of a qualitative significance.

2) BALANCE STUDIES:

These studies depend upon adequate methods for the determination of fat intake and fat excretion. In addition it has been pointed out frequently that fecal fat may not originate from dietary fat, but that it is secreted by the intestinal wall.

3) ANALYSIS OF THE INTESTINAL RESIDUE:

By this procedure the whole or an isolated part of the intestine is washed with some solvent in order to remove the fat present in the lumen. In addition to the fact that fat is secreted by the intestine, which may give erroneous results, it is necessary to prove that the washing of the intestine removes all the unabsorbed fat.

4) DETERMINATION OF BLOOD AND/OR LYMPH LIPIDS DURING FAT ABSORPTION:

The hemolipokrit method has largely been superseded by more adequate chemical methods, but even with the latter the results depend upon variation in the extraction of the fats and their subsequent treatment.

The chylomicron technique, even though it is a simple tool, is not satisfactory for quantitative studies. A good correlation has not always been found between the chylomicron count and the chemical determination of fat.

5) LABELED FATS:

Many procedures have been used to label the ingested fatty acids, but it is difficult not to vary the physical and chemical properties of the fats. Moreover, some labeling techniques produce fats which lose their identity during the absorption. The labeling with some of the newer isotopes seems most promis-

*Best, C. H. *Am. J. Dig. Dis.* 13, 155 (1946).

ing in this respect, but little work has so far been done with them. The interpretation of the data is difficult, however, as has been pointed out by some reviews on the use of labeling agents.

6) IN VITRO STUDIES:

These methods have been used extensively for the study of the action of bile and pancreatic enzymes on fat absorption. Even though much valuable information has been obtained, it should be recognized that the results are not always directly applicable to the living organism.

In the present bibliography extensive use has been made of the following journals from 1935 on: Index Medicus, Chemical Abstracts, Annual Reviews of Biochemistry, Annual Reviews of Physiology, Physiological Reviews, and Nutrition Reviews. To obtain an abstract of those articles that were not available to the author in their original form, the abstract contained in Chemical Abstracts was used, and this is indicated by the C.A. reference in addition to the original one. Much of the earlier work on fat absorption which is still quoted extensively in the present-day literature has also been incorporated into this bibliography.

II. GENERAL (1-7)

1. ON THE BEHAVIOR OF SOAP SOLUTION AT DIFFERENT H⁺ CONCENTRATIONS

A. Jarisch. *Biochem. Z.* 134, 163 (1922-23)

The surface tension, colloidal properties, etc. of soaps discussed.

2. CHEMICAL NATURE OF THE ULTRAMICROSCOPIC PARTICLES OF SERUM

R. N. Cunningham and B. A. Peters. *Biochem. J.* 32, 1482 (1932)

It is concluded that the smaller particles are protein but that the large bright particles are neutral fat.

3. THE COMPOSITION OF PARTICLES SEEN IN NORMAL HUMAN BLOOD UNDER DARK-GROUND ILLUMINATION

J. J. Elkes, A. C. Frazer, and H. C. Stewart. *J. Physiol.* 95, 68 (1939)

The conclusion arrived at, taking all the various points into consideration, is that the main bulk of the particle is fatty and that there may be a layer of adsorbed globulin at the oil-water interface.

It is suggested that serial counts give a reasonable indication of whether the blood fat is increasing or diminishing.

4. REACTIONS WITH MONOLAYERS AND THEIR BIOLOGICAL ANALOGIES

J. H. Schulman and E. K. Rideal. *Nature* 144, 100 (1939)

5. PERMEABILITY TO PROTEINS AND TO LARGE LIPOID MOLECULES

J. F. Danielli. *The Permeability of Natural Membranes* (1943)

6. THE BEHAVIOUR OF CHYLOMICRONS COMPARED WITH THAT OF PROTEIN PROTECTED SOAP STABILIZED OIL IN WATER EMULSIONS

A. C. Frazer and H. C. Stewart. *J. Physiol.* 95, 7P (1943)

It is shown that fat particles stabilized with soap to which a secondary protein film is added behave in a similar manner to chylomicrons.

7. REVERSIBLE ADSORPTION OF PROTEINS OF THE OIL/WATER INTERFACE

J. J. Elkes, A. C. Frazer, J. H. Schulman and H. C. Stewart.

Proc. Roy. Soc. A. 184, 102 (1945)

III . BOOKS AND REVIEWS (8-50)

8. CONTINUED INVESTIGATIONS ON THE ABSORPTION OF ARTIFICIALLY COLORED FATS

E. Pfluger. Arch. Physiol. Pflug. 85, 1 (1901)

9. CONTRIBUTION TO THE KNOWLEDGE OF THE PHYSIOLOGY OF FATS

E. F. Terroine. Contribution a la Connaissance de la Physiol. des Substan. Grasses et Lipoidiques. pg. 95 (1919)

Fat absorption:

Role of the stomach
Role of the intestine
Role of the liver and pancreas
Role of the pancreatic juice

Absorption of different neutral fats.

10. FAT TRANSPORT IN THE ANIMAL BODY

W. R. Bloor. Physiol. Rev. 2, 92 (1922)

The possibility of unsplit fats being absorbed is discussed, but it is thought likely that complete splitting occurs in the intestine before absorption.

11. THE DIGESTIBILITY OF FATS

C. F. Langworthy. Ind. Eng. Chem. 15, 276 (1923)

A review and compilation of the data on digestibility of animal fats, vegetable fats, and hydrogenated fats.

12. THE ABSORPTION OF FATS

Handb. d. Biochem. pg. 234 (1925)

Pathway of absorption.
Histological studies of fat absorption.
The absorption of lecithins.

13. THE DIGESTION AND ABSORPTION OF FATS

J. B. Leathes and H. S. Raper. The Fats, chap. V. (1925)

14. ABSORPTION

L. Pincussen. Handb. d. Biochem. 5, 295 (1925)

The utilization of foodstuffs. (Review)

15. PLACE OF FATS IN THE DIET

H. C. Sherman. Food Products pg. 460 (1928)

A discussion of the digestibility of different fats is given.

16. THE ABSORPTION FROM THE INTESTINE (REVIEW)

F. Verzar. Handb. der norm. u. pathol. Physiol. 4, 3 (1929)

17. PROBLEMS AND RESULTS IN THE FIELD OF INTESTINAL ABSORPTION

F. Verzar. Ergebnisse d. Physiol. 32, 391 (1931)

The following are discussed in great detail, and an extensive bibliography is presented: The mechanics of absorption, osmosis, hydrotropic substances, fat absorption - lipemia, absorption of cholesterol, sterols, absorption of calcium, and absorption of protein.

18. THE FAT ABSORPTION FROM THE INTESTINE AND ITS DISTURBANCES

H. Wendt. Ergebnisse Inn. Med. 42, 213 (1932)

Review: Physiology of fat absorption.
Physiology of lipoid absorption.
Disturbances of fat absorption.
Disturbances of cholesterol absorption.

19. THE ABSORPTION OF FATS

F. Verzar. Nutr. Abs. and Rev. 2, 441 (1933)

A critical survey of the work on fat absorption is given.

The role of bile in fat absorption and the significance of alimentary lipemia as a measure of fat absorption are discussed.

20. THE ABSORPTION FROM THE INTESTINE

F. Verzar. Klin. Wochschr. 12, 489 (1933)

The fact is stressed that the pH of the small intestine is acid except for the small upper part, which is alkaline. This makes it impossible for fats to be absorbed as soaps.

Four principles are recognized to be important in fat absorption:

- 1) the substance becomes water soluble and diffusible.
- 2) the diffusibility is produced by the reaction of a hydrotropic substance.
- 3) the solubility depends on the pH.
- 4) surface reactions effect the membrane permeability.

It was shown (Laszt 1934, 1935) that iodoacetic acid and phlorizin inhibit absorption. Also adrenalectomy inhibits absorption of fats; cortin reestablishes the normal condition.

21. THE PHYSIOLOGY OF THE PHOSPHOLIPIDS

R. G. Sinclair. Physiol. Rev. 14, 351 (1934)

In man and dog the feeding of fat increases blood total fat and phospholipids. In herbivorous animals (rabbit, cow) no acute alimentary lipemia or increase in phospholipid level occurs. In the latter there may be a lower rate of absorption than assimilation.

22. PROGRESS IN MEDICINE; CHOLESTEROL METABOLISM

A. Cantarow. *New Internat. Clin.* 1, 237 (1935)

Review - A section on the absorption and excretion of cholesterol is presented.

23. PHYSIOLOGY OF THE STEROLS, INCLUDING VITAMIN D

C. E. Bills. *Physiol. Rev.* 15, 1 (1935)

Review.

24. FAT METABOLISM

Camillo Artom. *Ann. Rev. Biochem.* 4, 199 (1935)

The author adheres to the belief that the blood corpuscles are largely concerned in the transport of ingested or mobilized lipids, especially phospholipids.

25. ABSORPTION OF FATS

F. Verzar and E. J. McDougall. *Absorption from the Intestine*, chap. X, (1936)

A detailed discussion of the action of bile is given, and it is stressed that the main action of bile is neither emulsification of the fat nor activation of the lipase but solution of the fatty acids. Influence of phlorhizin, adrenals, pancreas, etc. on fat absorption is discussed extensively. The histological changes in the intestine are presented in great detail.

26. FAT METABOLISM (REVIEW)

E. F. Terroine. *Ann. Rev. Biochem.* 5, 227 (1936)

27. FAT METABOLISM (REVIEW)

R. G. Sinclair. *Ann. Rev. Biochem.* 6, 245 (1937)

The article stresses the belief that fatty acids liberated by enzymic action in the small intestine are absorbed into the epithelial cells and resynthesized into neutral fat.

Desaturation of ingested fat in the small intestine is considered.

Hypotheses: Liver and plasma phospholipids originate in the small intestine.

28. THE ROLE OF FAT IN THE DIET (REVIEW)

W. E. Anderson and H. H. Williams. *Physiol. Rev.* 17, 335 (1937)

Pg. 361 - Digestibility and absorption of fat.

29. THE BIOCHEMISTRY OF THE LIPIDS (MONOGRAPH)

H. B. Bull. (1937)

The physiology of the lipids (e.g., absorption, excretion, transport and storage) is discussed in detail.

30. FAT METABOLISM

F. Verzar. *Ann. Rev. Biochem.* 7, 160 (1938)

Sections on the digestion of different fats, pg. 165, and phospholipids in fat absorption, pg. 171, are presented.

31. THE DIGESTIVE AND ABSORPTIVE FUNCTION OF THE EXTERNAL SECRETION OF THE PANCREAS (REVIEW)

M. B. Handelsman. *Ann. Int. Med.* 11, 1479 (1938)

Most of the digestive and absorptive phenomena found in depancreatized dogs are found in dogs with their pancreatic ducts ligated.

The internal secretions postulated to explain fat absorption or to regulate gastrointestinal motility are not substantiated.

The fat absorption is labile, but the factors causing these variations are not completely understood.

An extensive bibliography is presented.

32. INTERMEDIARY METABOLISM OF THE LIPIDS

W. R. Bloor. *Oil and Soap* 15, 63 (1938)

In the intestine complete breakdown of fats occurs. Phosphorylation is important in absorption and phospholipids may be directly absorbed in the blood stream. Most of the absorbed fat appears in the thoracic duct. Most of the fat is transported as fat, whether from the intestine or from the stores.

33. FAT TRANSPORT IN THE ANIMAL BODY (REVIEW)

W. R. Bloor. *Physiol. Rev.* 19, 557 (1939)

The paper considers practically all evidence in favor of complete splitting of fat in the intestine. Bile is considered to be the most important single factor in fat absorption.

Absorption of fat directly into the blood stream is still considered to be unsettled.

34. LIPID METABOLISM (REVIEW)

Warren M. Sperry. *Ann. Rev. Biochem.* 8, 231 (1939)

Doubts of Verzar's experiments on absorption have arisen:

Klinghoffer showed severe intestinal pathology after monoiodoacetic acid administration, and Lambrechts showed that phlorizin does not act specifically on phosphorylation but is generally toxic to cells.

35. FAT METABOLISM

H. J. Channon. *Ann. Rev. Biochem.* 9, 231 (1940)

A section on fat absorption is presented.

36. DISTURBANCES OF FAT ABSORPTION IN THE INTESTINE

F. W. Schembra. *Klin. Wochschr.* 19, 385 (1940)

A review.

37. FAT ABSORPTION AND ITS RELATIONSHIP TO FAT METABOLISM

A. C. Frazer. *Physiol. Rev.* 20, 561 (1940)

Breaking down of neutral fat and its resynthesis in the intestinal wall have not been proved. If neutral fat is absorbed by the lymphatics and fatty acid by the portal system, the amount of lipolysis will determine the pathway. The significance of the cholesterol ester metabolism remains obscure.

38. FAT METABOLISM (REVIEW)

Henry C. Eckstein. *Ann. Rev. Biochem.* 10, 181 (1941)

The controversy of absorption of hydrolysed fats by portal blood (Frazer) and by lymph (Freeman, Johnson) is presented.

39. FAT METABOLISM

E. Chargaff. *Ann. Rev. Biochem.* 11, 235 (1942)

A section on the absorptioi. of glycerides and fatty acids is presented.

40. REVIEW

E. S. Savage, and C. McCay. *J. Dairy Sci.* 25, 595 (1942)

A section on fat utilization of calves is given. Apparently not many reliable data were available at the time.

41. FAT METABOLISM

G. O. Burr and R. H. Barnes. *Ann. Rev. Biochem.* 12, 157 (1943)

A section on the absorption of fats is presented.

42. NON-CALORIC FUNCTIONS OF DIETARY FATS

G. O. Burr and R. H. Barnes. *Physiol. Rev.* 23, 256 (1943)

A section on the digestibility of fats and the different factors influencing it is presented. It is concluded that digestibility depends more upon the amounts of longer chain saturated acids than upon the total saturated acids. Melting point is no exact index of the digestibility of mixed fats.

43. BIOCHEMISTRY OF THE FATTY ACIDS

W. R. Bloor. Reinhold Pub. Corp., New York (1943)

An extensive bibliography on fat absorption is presented. The view is held that all the fat is completely split in intestine **and** it is absorbed as fatty acid. The phosphorylation of fat in the intestine is said to be essential in resynthesis. Leucocytes may play a considerable part in the transport of fat to the lacteals.

44. FAT METABOLISM

R. H. Barnes and E. M. McKay. *Ann. Rev. Biochem.* 13, 211 (1944)

A section on digestion and absorption is presented.

45. VITAMIN A ABSORPTION IN CASES OF PROTOZOAN INFESTATION

Nutr. Rev. 2, 247 (1944)

A short review of the literature on disturbances in fat absorption due to infestation with *Giardia lamblia* is presented.

46. BLOOD

Victor Johnson, L. Willard Freeman and Joan Longini. *Ann. Rev. Physiol.* 7, 365 (1945)

A short review about the destructive action of absorption products of fat on red blood cells is presented.

47. DIGESTIVE SYSTEM

B. P. Babkin and M. H. F. Friedman. *Ann. Rev. Physiol.* 7, 305 (1945)

A review of work on fat absorption during the last few years is presented.

48. RELATIVE NUTRITIVE VALUES OF ANIMAL AND VEGETABLE FATS

G. R. Cowgill. *Physiol. Rev.* 25, 664 (1945)

A presentation of the data on the digestibility of different fats is given. It is concluded that all edible fats the melting points of which are not too high to prevent liquefaction in the alimentary tract are digested and absorbed to about the same degree and that such differences as have been found are of no practical nutritional significance.

49. THE ABSORPTION OF TRIGLYCERIDE FAT FROM THE INTESTINE

A. C. Frazer. *Physiol. Rev.* 26, 103 (1946)

Evidence is cited for:

1. The partial hydrolysis of triglyceride in small intestine, favoring the formation of a stable emulsion.
2. The existence of canals in the small intestinal wall (histological).
3. The importance of emulsification in the absorption of paraffins.
4. Possible connection between electrolyte absorption and the passage of fat particles through the small intestinal wall.

5. The fact that adrenalectomy may upset the normal electrolyte balance and not interfere with phosphorylation (compare Verzar, etc.).
6. The absorption of long chain fats especially, in particulate form.
7. Stabilization of the fat particles in blood (chylomicrons) by phospholipids formed in the small intestine.
8. The difference of symptoms after feeding fat and fatty acid (lipemia, etc.).
9. The partition theory as alternative to lipolysis theory.

50. FACTORS AFFECTING FAT TRANSPORT IN THE ANIMAL BODY (REVIEW)

C. H. Best. Am. J. Dig. Dis. 13, 155 (1946)

Among other things, the different stages of fat during fat absorption and the possible pathways involved are discussed.

**IV. ABSORPTION OF DIFFERENT FATS (THEIR PHYSICAL
AND CHEMICAL PROPERTIES, DIGESTIBILITY, ETC.) (51-131)**

A. Methods

B. Absorption by Different Species

- 1. Human Subjects**
- 2. Rats**
- 3. Dogs**
- 4. Fowls**
- 5. Other Animals**

A. METHODS

51. THE CALCULATION OF THE DIGESTIVE COEFFICIENT OF FAT

S. Suzuki. J. Agr. Chem. Soc. (Japan) 9, 803 (1933)

52. A TECHNIC FOR DETERMINING THE RATE OF ABSORPTION OF FATS

Margaret House Irwin, H. Steenbock and Vera May Templin. J. Nutr. 12, 85 (1936)

Fat absorption is measured as the difference between the ingested fat and the residual fat in the intestine. The CHYLOMICRON method was found to have no quantitative value. The HAEMOLIPOKRIT method did not give results that agreed with the method proposed here.

No definite correlations were found between the amount of fat absorbed and body weight, body surface or length of intestine.

53. A SIMPLE PROCEDURE OF THE STUDY OF FAT ABSORPTION

H. J. Deuel, L. Hallman and S. Quor. J. Biol. Chem. 128, xix (1939)

A method for determining the amount of fat in the lumen of the intestine is described.

54. CHYLOMICROGRAPH TECHNIQUE

A. C. Frazer and H. C. Stewart. J. Physiol. 95, 21P (1939)

A description of the chylomicrograph technique and its common difficulties is given.

55. A SPECTROPHOTOMETRIC METHOD FOR THE STUDY OF FAT TRANSPORT AND PHOSPHORYLATION

Elmer S. Miller, Richard H. Barnes, J. P. Kass and G. O. Burr, Proc. Soc. Exp. Biol. and Med. 41, 485 (1939)

Conjugated double bond fatty acids of corn oil are prepared and measured spectrophotometrically. It can be seen that the extraction procedure for these acids is not quantitative.

The acetone soluble and acetone insoluble fraction only give an 80 per cent recovery of the total. The loss may be due to oxidation.

The changes of the conjugated fatty acids in vivo make the measurements less reliable and the authors ARBITRARILY restrict their experiments to a duration of 6 hours.

(See also No. 487.)

B. ABSORPTION BY DIFFERENT SPECIES

(See also Nos. 352, 356, 359, 360, and 361.)

1. Human Subjects

56. ON THE UTILIZATION OF SOME FOODS IN THE HUMAN INTESTINE

Max Rubner. Z. Biol. 15, 115 (1879)

57. INVESTIGATIONS ABOUT THE DIGESTIBILITY OF BUTTER AND SOME OF ITS SUBSTITUTES

H. Wibbens and H. Huzenga. Arch. Physiol. Pflug. 83, 609 (1901)

It is found that the substitutes (margarine) have as much food value for dogs and human subjects as butter.

58. GASTROINTESTINAL STUDIES. XI. STUDIES ON THE RELATIVE DIGESTIBILITY AND UTILIZATION BY THE HUMAN BODY OF LARD AND HYDROGENATED VEGETABLE OIL

C. A. Smith, R. J. Miller and P. B. Hawk. J. Biol. Chem. 23, 505 (1915)

The hydrogenated vegetable oil used in this experiment was as satisfactorily digested and utilized by normal men as was lard.

59. ON THE USE OF HARDENED FATS IN THE FOOD INDUSTRY

H. Thoms and F. Muller. Arch. f. Hyg. 84, 54 (1915)

Whale oil, peanut oil, sesame oil, cotton seed oil and their hardened products were tested on men, dogs and cats. It is concluded that all are well utilized, even though the fats melting below 37° C are digested more completely than the higher-melting fats.

60. DIGESTIBILITY OF SOME ANIMAL FATS

C. F. Langworthy and A. D. Holmes. U. S. Dept. Agr. Bull. 310, (1915).

The digestibility of the following fats tested on human subjects was found to be related to their melting points:

	DIGESTIBILITY per cent	MELTING POINT °C
Butter fat	97	32
Lard	97	35
Beef fat	93	45
Mutton fat	88	50

61. DIGESTIBILITY OF SOME VEGETABLE FATS

C. F. Langworthy and A. D. Holmes. U. S. Dept. Agr. Bull. 565, (1917)

OIL	DIGESTIBILITY
Olive Oil	97.8
Cottonseed oil	97.8
Peanut oil	98.3
Coconut oil	97.9
Sesame oil	98
Cocoa butter	96.9

The melting points of these fats are considerably below 37° C.

62. STUDIES ON THE DIGESTIBILITY OF SOME ANIMAL FATS

C. F. Langworthy and A. D. Holmes. U. S. Dept. Agr. Bull. 507, (1917)

OIL	DIGESTIBILITY
Chicken fat	96.7
Goose fat	95.2
Brisket fat	97.4
Butter fat (cream)	96.9
Egg yolk fat	93.8
Fish flesh fat	95.2

63. DIGESTIBILITY OF SOME SEED OILS

A. D. Holmes. U. S. Dept. Agr. Bull. 687, (1918)

OIL	DIGESTIBILITY
Corn oil	96.8
Soy bean oil	97.5
Sun flower seed oil	96.5
Japanese mustard seed oil	98.8
Rapeseed oil	90.9
Chorlock oil	98.9

64. STUDIES ON THE DIGESTIBILITY OF SOME NUT OILS

A. D. Holmes. U. S. Dept. Agr. Bull. 630, (1918)

OIL	DIGESTIBILITY
Almond oil	97.1
Black-walnut oil	97.5
Brazil-nut oil	96.3
Butter-nut oil	95.4
English-walnut oil	97.6
Hickory-nut oil	99.3
Pecan oil	96.8

65. THE DIGESTION AND ABSORPTION OF FATS

A. W. Bosworth, H. I. Bowditch and Louise A. Giblin. Am. J. Dis. Child. 15, 397 (1918)

It is shown that much fat is excreted by infants fed on cow's milk. The calcium content of the milk and the solubility of the calcium compounds present are correlated with this fat excretion.

66. HARDENED WHALE OIL AS A HUMAN FOOD

A. Erlandsen, L. S. Fridricia and A. Elgstrom. Tidskrift Kem. 15, 109 (1918) C. A. 1793 (1918)

The digestibility in humans of hardened whale fat is found to be approximately equal to that of butter fat.

67. ON THE DIGESTIBILITY OF COCOA BUTTER

J. A. Gardner and F. W. Fox. Biochem. J. 13, 368 (1919)

Cocoa butter is rather less digestible than butter, but the experiments on human subjects show satisfactory utilization. Large amounts of the fat produced a slight laxative effect.

68. DIGESTIBILITY OF CERTAIN MISCELLANEOUS ANIMAL FATS

A. D. Holmes. U. S. Dept. Agr. Bull. 613, (1919)

FAT	DIGESTIBILITY
Goat butter	98.4
Kid fat	95.3
Hard-palate fat	93.7
Horse fat	93.9
Oleo oil	96.8
Oleo stearin	80.1
Ox-marrow fat	96.6
Turtle fat	98.6

69. DIGESTIBILITY OF SOME BY-PRODUCT OILS

A. D. Holmes. U. S. Dept. Agr. Bull. 781, (1919)

OIL	DIGESTIBILITY
Apricot kernel oil	98.4
Cherry kernel oil	98.0
Melon seed oil	98.2
Peach kernel oil	96.6
Pumpkin seed oil	98.2
Tomato seed oil	95.8

70. DIGESTIBILITY OF CERTAIN MISCELLANEOUS VEGETABLE FATS

A. D. Holmes and H. J. Deuel. J. Biol.Chem. 41, 227 (1920)

FAT	DIGESTIBILITY
Avocado fat	87.9
Cohune oil	99.1
Capuassu fat	94.1
Hempseed oil	98.5
Palm kernel oil	98.0
Poppyseed oil	96.3

Capuassu fat was the only one that produced slight intestinal disturbances in the subjects.

71. DIGESTIBILITY OF SOME HYDROGENATED OILS

A. D. Holmes and H. J. Deuel. *Am. J. Physiol.* 54, 479 (1921)

Cottonseed, peanut and corn oil were hydrogenated and fed to human subjects. Hydrogenated oils are as well utilized as natural fats of corresponding melting points.

OILS	MELTING POINT	IODINE NUMBER	DIGESTIBILITY
Cotton seed	35	89.6	96.8
	38.6		95.5
	46	72.8	94.9
Peanut	37	81.3	98.1
	39		95.9
	43	78.8	96.5
	50	58.5	92.0
	52.4		79.0
Corn	33	89.0	94.7
	43	74.9	95.4
	50	55.4	88.5

72. DIGESTIBILITY OF CODLIVER, JAVA ALMOND, TEA SEED AND WATERMELON SEED OILS, DEER FAT, AND SOME BLENDED HYDROGENATED FATS

H. J. Deuel. *U. S. Dept. Agr. Bull.* 1033, (1922)

KIND OF OIL OR FAT	MELTING POINT (°C)	DIGESTIBILITY
Codliver oil		97.7
Java almond oil		97.0
Tea seed oil		91.2
Watermelon seed oil		94.8
Deer fat	51.4	81.7
Blended hydrogenated fats:		
Corn fat	39.0	95.2
Do	49.0	93.3
Do	54.0	91.5
Cottonseed fat	41.3	96.6
Do	45.8	96.4
Do	47.8	94.2
Do	48.1	96.4
Do	50.0	87.0
Peanut fat	43.0	96.6
Do	43.2	97.4
Do	51.1	92.8

73. NOTES ON THE ETHER EXTRACT OF FECES

A. D. Holmes and R. Kerr. *J. Biol. Chem.* 58, 377 (1923)

Digestibility of fats in humans was found as follows:

Lard	95%
Butter	95%
Goose fat	97%
Chicken fat	94%
Egg yolk fat	92%

74. DIGESTIBILITY OF FATS TAKEN FROM THE ANIMAL BODY

A. D. Holmes. *J. Oil and Fat Ind.* 3, 11 (1926). *C.A.* 2006 (1926)

The digestibility was measured on human subjects.

Brisket fat, butter cream and ox tail fat	97%
Hard-palate fat, kidney fat, ox-marrow fat	94%
Oleo oil	97%
Oleo stearin	85%

75. STUDIES OF FAT METABOLISM IN INFANTS

L. E. Holt, H. C. Tidwell and C. M. Kirk. *Acta Paediatrica* 16, 165 (1933)

There is an inverse relationship between the mineral intake and fat retention. The particle size of the fat is not important, but the presence of double bonds rather than the low melting point is the determining factor for completeness of absorption. Triolein is found to be absorbed better than butter fat or breast milk fat.

76. COMPARISON OF BUTTER AND MARGARINE IN FEEDING CONVALESCENTS

S. Badykkes, E. Einhorn, W. Kudaschewitsch and W. Sykoff. *Arch. Verd. Krankh.* 56, 293 (1934)

Margarine delays the secretion less than butter but is somewhat more effective in the inhibition of stomach emptying.

Butter fat seems to be utilized a little better than margarine.

77. STUDIES IN FAT METABOLISM. I. FAT ABSORPTION IN NORMAL INFANTS

L. E. Holt, H. C. Tidwell, C. Kirk, D. Cross and S. Neale. *J. Pediatrics.* 6, 427 (1935)

The size of the fat particles does not influence fat absorption. Absorption of fat is favored by fatty acids containing one or more unsaturated linkages and short carbon chains. The melting point is not per se a factor in fat absorption. Ethyl esters are split with difficulty and are not as well absorbed. As a rule, fats are completely split in the intestine, the fecal "neutral fat" usually being unsaponifiable material.

78. STUDIES IN FAT METABOLISM. II. FAT ABSORPTION IN PREMATURE INFANTS AND TWINS

H. C. Tidwell, L. E. Holt, H. L. Farrow and S. Neale. *J. Pediatrics* 6, 481 (1935)

It is confirmed that premature infants have marked difficulty in fat absorption; fat splitting is less complete in the premature than in the full-term infant.

Olive oil, soybean oil are far better absorbed than butter fat. The presence of more than one double bond in a fatty acid favors fat absorption.

79. V. Ducceschi and A. Roncato. *Quarderni nutriz* 3, 368 (1936). *Ann. Rev. Biochem.* 7, 165 (1938)

In men fed with 100 gm. of five differently purified olive oils, 93.4 to 95.8 per cent was absorbed.

80. INTESTINAL ABSORPTION OF VARIOUS LIPIDES BY SUCKLINGS

G. Frontali. Boll. Soc. Ital. Biol. Sper. 13, 1057 (1938). C. A. 8700 (1939)

The percentage absorption of fats or oils ingested is greatest with oils rich in triolein (e.g., 90-97 and 88-95% for olive and soybean oil, respectively). The relationship between composition and absorption of various fats and oils is discussed.

81. THE ABSORPTION OF HARD FAT

F. Rennkamp. Ber. Verhandl. Sachs. Akad. Wiss-Leipzig, Math-Phys. Klassen 91, 61 (1939). C. A. 6922 (1939)

Ingested neutral hard fat was extensively hydrolysed in human subjects. The total absorption was usually less than 50%. The short chain fatty acids were absorbed most efficiently.

82. THE FECES OF CHILDREN FED WITH SOURED WHOLE MILK. INVESTIGATION OF THE RESORPTION OF FAT

P. Girand. Vidal Nourrisson 27, 1 (1939). C. A. 7362 (1940)

The utilization of the fat from this product was very satisfactory. The utilization coefficient exceeded 94%.

83. A COMPARISON OF THE DIGESTIBILITY OF MEALS PREPARED WITH ANIMAL VERSUS HYDROGENATED VEGETABLE COOKING FATS

C. S. Smith. Ohio State Med. J. 39, 425 (1943)

Lard appears to be over four times as likely to cause gastric or intestinal disturbances of an objective nature as hydrogenated vegetable fat.

84. EFFECT OF THERMAL TREATMENT ON THE ABSORPTION OF A FEW ANIMAL FATS AND HYDROGENATED GROUNDNUT OIL

A. Roy. Ann. Biochem. and Exp. Med. 4, 71 (1944). C. A. 4657 (1945)

The presence, in the digestive tract, of unsaponifiable matter from normal and thermally treated oils influences neither rate of hydrolysis of fat nor its subsequent absorption.

(See also Nos. 427, 482 and 514.)

2. Rats

85. DIGESTIBILITY OF AVOCADO AND CERTAIN OTHER OILS

H. J. Deuel and A. D. Holmes. *Science* 51, 379 (1920)

Determinations on humans

FAT	DIGESTIBILITY per cent
Avocado	82.5
Capuassu	92.7
Cohune oil	99.0
Hempseed oil	98.5
Palm kernel oil	98.0
Poppy seed oil	96.3

86. ON THE RELATIVE NUTRITIONAL VALUE OF DIFFERENT SYNTHETIC FATS

J. Ozaki. *Biochem Z.* 177, 156 (1926)

Different fats were added to the diet of rats, and the increase in weight was taken as index of the food value of the fat.

It was found that:

Uneven C. chain fats have less food value than the natural occurring fats.
Tristearin and margarine were always less digestible.

87. THE EFFECT OF THE SATURATED FATTY ACID CONTENT OF THE DIET ON THE COMPOSITION OF THE BODY FAT

A. D. Barbour. *J. Biol. Chem.* 106, 281 (1934)

The arachidic acid of peanut oil is almost quantitatively excreted by the albino rat.

88. COMPARATIVE STUDIES ON THE ABSORPTION OF THE OLEIC ACID IN MONO-OLEIN AND DIOLEIN

G. Peretti. *Boll. Soc. Ital. Biol. Sper.* 10, 873 (1935). C. A. 2625 (1936)

Rats were used.

Free oleic acid is poorly absorbed. The mono and diolein are absorbed with a velocity equal to that of the triglycerides.

89. FATS PLAY IMPORTANT ROLE IN ANIMAL NUTRITION

H. Steenbock, M. Irwin, A. R. Kemmerer, V. M. Templin and J. H. Weber. *Wis Agr. Exp. Sta.* 430, 127 (1935)

The rates at which different fats are absorbed by rats was determined. In four hours the amount absorbed is: cod liver oil, butter oil, halibut liver oil, 70%; butter 60%; cottonseed oil, lard, corn oil, soybean oil, hydrogenated fats, 50-60%.

Fats with melting points well above body temperature were absorbed very slowly. Compounds that were found to decrease the fat absorption when added to the diet were: bile, Na benzoate, alcohol, peptone, and cane sugar.

90. THE INTESTINAL ABSORPTION OF OILS WITH A VARYING DEGREE OF UNSATURATION

G. Peretti and L. Reale. *Boll. Soc. Ital. Biol. Sper.* 10, 871 (1935). C. A. 2625 (1936)

Cacao butter and olive, sesame, papaver, and cottonseed oil (1-2 g.) were administered to five groups of albino rats. The animals were killed after 6 hours and the amount of fat present in the stomach and intestine was determined. The results indicate that there is no parallelism between the degree of unsaturation and absorption.

91. THE COMPARATIVE RATE OF ABSORPTION OF DIFFERENT FATS

H. Steenbock, Margaret House Irwin and Janet Weber. *J. Nutr.* 12, 103 (1936)

The per cent absorption 2, 4, 6, 8, 12 hours after feeding fat to rats was determined. Butter oil, halibut liver oil, and cod liver oil were absorbed more rapidly than lard, corn oil, or partially hydrogenated fats.

Other fats tested in the descending order of absorption were: linseed oil, olive oil, whale oil, soya bean oil, peanut oil, rancid lard, cottonseed oil, cocobutter, coconut oil, palm oil, and oleo stock.

The quantity of unsaponifiable matter may influence the rate of absorption of the total crude fat.

92. THE INFLUENCE OF HYDROGENATION AND OXIDATION OF FATS UPON THEIR RATE OF ABSORPTION

Margaret House Irwin, Janet Weber, H. Steenbock and T. M. Godfrey. *Am. J. Physiol.* 124, 800 (1938)

Rats were fed 1.5 cc. fat by stomach tube.

The fats which showed higher melting points than body temperature were less readily absorbed as their melting points increased. Variation in melting points below body temperature did not have any effect.

When the degree of oxidation was increased, absorption was slowed.

93. A BALANCE SHEET OF FAT ABSORPTION: I. THE STORAGE OF ELAIDIC ACID BY THE RAT OVER A ONE DAY PERIOD

Mathias F. F. Kohl. *J. Biol. Chem.* 126, 709 (1938)

Elaidin is absorbed at constant rate; most of it is metabolized, with the balance going to the tissues. When protein and CHO are fed with elaidin, absorption is slower, but more goes to the tissues. A regulatory mechanism is proposed which stops the flow of fat from depots when absorption of fat begins, only the excess absorbed being stored.

94. A BALANCE SHEET OF FAT ABSORPTION: II. THE STORAGE OF ELAIDIC ACID BY THE RAT OVER PERIODS OF SEVERAL DAYS

Mathias F. F. Kohl. *J. Biol. Chem.* 126, 721 (1938)

The conclusions drawn from these feeding experiments are the same as in *J. Biol. Chem.* 126, 709 (1938).

95. A BALANCE SHEET OF FAT ABSORPTION: III. THE DISAPPEARANCE OF ELAIDIC ACID FROM THE TISSUES OF THE RAT

Mathias F. F. Kohl, J. Biol. Chem. 126, 731 (1938)

Elaidic acid that was deposited on feeding elaidin as 40% of caloric intake for 3 days required over 30 days to be removed from the adipose tissues.

96. INTESTINAL ABSORPTION OF CHAULMOOGRA OIL

B. E. Abreu, C. A. Emerson and S. A. Peoples. Univ. Calif. Publ. Pharmacol. 1, 275 (1940)

Chaulmoogra oil is absorbed from the intestine of intact rats after oral administration at least as well as olive oil.

No significant difference was found between the absorption from loops of small intestine in situ of Na-chaulmoograte and Na-oleate.

97. THE COMPARATIVE RATE OF ABSORPTION OF SOME NATURAL FATS

Harry J. Deuel, Jr., Lois Hallman and Alvin Leonard. J. Nutr. 20, 215 (1940)

Hydrogenated cottonseed oil, "wintered" cottonseed oil, butter, fat, and coconut oil all were absorbed at the same rate by rats. Rape-seed oil was absorbed somewhat more slowly.

The quantity of fat absorbed increases with the amount fed, and with the size of the rat. Comparisons on the basis of body surface are found to be most uniform. The rate of absorption is 40-50 mg. per 100 sq. cm. per hour up to 6 hours.

98. THE RATE OF ABSORPTION OF SYNTHETIC TRIGLYCERIDES IN THE RAT

Harry J. Deuel, Jr., and Lois Hallman. J. Nutr. 20, 227 (1940)

Fats are absorbed in decreasing amounts in the following order: triacetin, tributyrin, tricaproin, tricaprylin, trilaurin, the last one being removed from the small intestine of rats very slowly (high melting point).

The odd-chain fatty acid fats (tripropionin, trivalerin, triheptylin) were absorbed at a rate 50% or less of that characteristic of the corresponding even-chain fats. Triisovalerin was absorbed at a rate comparable to even-chain fats.

99. NUTRITIVE PROPERTIES OF CERTAIN ANIMAL AND VEGETABLE FATS

R. Hogland and G. G. Snider. Tech. Bull. U. S. Dept. Agr. 725, 12 (1940)

FAT AS	DIGESTIVE COEFFICIENT FOR RATS		
	AS 5% DIET WT.	AS 30% DIET WT.	AS 55% DIET WT.
refined lard	97.6%	96.5%	95.5%
cottonseed oil	96.6	97.2	
neutral lard	95.2	93.7	92.5
leaf lard	93.4	93.0	94.5
peanut oil	93.1	95.7	
hydrogenated lard	89.0	92.4	94.0
hydrogenated cottonseed oil	88.2	92.2	93.7
oleo oil	86.2	89.8	92.3

The growth-promoting value did not show a consistent relationship to its digestive coefficient. The iodine numbers of the undigested fatty acids indicated a pronounced selective absorption of the unsaturated fatty acids. The iodine numbers of metabolic fat indicated that unsaturated fatty acids are a normal excretory product of the albino rat.

100. ABSORPTION AND DEPOSITION OF FAT

E. Nitschke. Ber. Naturforsch. Ges. Freiburg-Breisgau 37, 43 (1941). C. A. 4433 (1943)

In rats cooking fat, olive oil and two artificial fats showed a decreasing tendency to increase their weight. The artificial fats produced a smaller weight increase than a fat-free diet.

101. THE RATE OF ABSORPTION OF VARIOUS FATTY ACIDS BY THE RAT

Harry J. Deuel, Jr., Lois Hallman and A. Reifman. J. Nutr. 21, 373 (1941)

The even-chain fatty acids are absorbed more rapidly than the uneven-chained ones. Sodium acetate was absorbed at a slower rate than would have been expected from the rate of absorption of triacetin. Lauric acid was absorbed much more slowly than tri-laurin, even though its melting point is 2° lower.

102. THE COMPARATIVE RATES OF ABSORPTION OF EGG OIL AND COD LIVER OIL

R. Reder. Poultry Sci. 21, 528 (1942)

At the end of a 10-hour absorption period 97.7% of egg oil and 87.2% of cod liver oil had been absorbed from the rat's intestine after stomach tube feeding of + 1.5 ml. of each oil.

103. DIFFERENTIATION IN THE ABSORPTION OF OLIVE OIL AND OLEIC ACID IN THE RAT

A. C. Frazer. J. Physiol. 102, 206 (1943)

Neutral fat absorption gives rise to large globules in the intestinal cell, whereas fatty acid absorption shows a fine brown granular deposit.

Neutral fat absorption is accompanied by milky lacteals; not so with fatty acid absorption.

Neutral fat absorption gives a systemic lipaemia, but little change in the portal blood. Fatty acid causes a marked portal lipaemia with little change in the systemic blood, as determined with chylomicron method.

Neutral fat can be traced to the fat depots, and, provided it is administered in moderate doses, fails to give marked deposition in the liver.

Fatty acid, on the other hand, does not appear in the fat depots, but it does give rise to a marked deposition in the liver (as determined with Sudan IV).

104. DIGESTIBILITY OF SOME ANIMAL AND VEGETABLE FATS

Ralph Hoagland and George G. Snider. J. Nutr. 25, 295 (1943)

The true digestive coefficients of several animal and vegetable fats were determined by experiments with young male albino rats. Each fat was incorporated in an otherwise adequate diet in the proportions of 5 and 15% of weight, corresponding to 12.5 and 32.7% of the total energy values of the diets.

When the diets contained 5% of fat, the following digestive coefficients were obtained: coconut oil 98.9; soybean oil 98.5; corn oil 97.5; butterfat 88.3; mutton tallow 74.6; oleo stock 74; and cacao butter 63.3%.

When the diets contained 15% of fat, the digestive coefficients were as follows; soybean oil 98.3; corn oil 98.3; coconut oil 96.5; butterfat 90.7; oleo stock 86.7; mutton tallow 84.8; and cacao butter 81.6%.

There was no consistent relationship between the melting points of the fats and their digestive coefficients.

It was suggested that possibly the stearic acid content decreases the digestibility of a fat.

105. DIGESTIBILITY OF CERTAIN HIGHER FATTY ACIDS AND TRIGLYCERIDES

Ralph Hoagland and George G. Snider. J. Nutr. 26, 219 (1943)

The fats and fatty acids are mixed with olive oil in different proportions before they were fed to rats.

Stearic acid and tristearin were very poorly absorbed.

Palmitic acid and tripalmitin were much more digestible.

Myristic, lauric acid, trimyristin, trilaurin were very completely utilized.

106. NUTRITIVE PROPERTIES OF LARD AND OTHER SHORTENINGS

R. Hoagland and G. G. Snider. Tech. Bull. U. S. Dept. Agr. 821, 12 (1944)

Experiments on rats.

FAT	DIGESTIVE COEFFICIENTS
Leaf lard	91.2
Steam rendered lard	95.4
Vegetable shortening	84.6-91.5
Vegetable and animal shortening	83.5-87.0

There was no consistent relationship between the percentage of saturated fatty acids in a shortening or its melting point and the digestive coefficient.

107. THE NUTRITIVE VALUE OF THE FATTY ACIDS OF BUTTER INCLUDING THEIR EFFECT ON THE UTILIZATION OF CAROTENE

E. F. Brown and W. R. Bloor. J. Nutr. 29, 349 (1945)

The absorption was measured on rats:

DIET	PER CENT ABSORBED
butter	93.0
volatile acids	90.6
low liquid acids	95.0
high liquid acids	93.3
low solid acids	71.3
high solid acids	42.2

108. THE RELATION OF GLYCERIDE STRUCTURE TO FAT DIGESTIBILITY

K. F. Mattil and J. W. Higgins. J. Nutr. 29, 255 (1945)

Synthetic glycerides containing stearic and oleic acids have been prepared and incorporated into the diets of rats. The stearic acid in the glycerides has been shown to be very indigestible. It is better utilized when fed as mixed glycerides than when fed as tristearin mixed with triolein. The possibility of selective utilization of fat acids has been indicated.

Support is given to the hypothesis that either hydrolysis of glycerides or ester interchange precedes absorption.

109. TOLERANCE FOR SYNTHETIC FATS WITH FATTY ACIDS HAVING 6-12 CARBON ATOMS

H. Krout, A. Weicher and T. Hugel. Biochem. Z. 317, 187 (1944). C. A. 628 (1946)

In rats and dogs the utilization of synthetic fats with 6-12 C atoms is the same as that of soybean oil (97.5-98.5%).

(See also Nos. 52, 114, 130, 178, 207 and 279.)

3. Dogs

110. EXPERIMENTS ON THE ABSORPTION OF DIFFERENT FATS FROM THE INTESTINE

L. Arnschink. Z. Biol. 26, 434 (1890)

Tristearin, pig fat, mutton tallow, goose fat were fed to dogs, and their absorption was measured.

111. ON FAT ABSORPTION

Otto Frank. Z. Biol. 36, 568 (1898)

The ethyl esters of the higher fatty acids are absorbed by the dog; only the stearic ester is not. They are split in the intestine, and no trace could be detected in the lymph.

112. EXPERIMENTS BEARING ON THE FUNCTIONS OF THE LIVER IN THE METABOLISM OF FATS. I.

H. S. Raper. J. Biol. Chem. 14, 117 (1913)

Cats and dogs are used.

When coconut oil is being absorbed, the fat in the chyle contains fatty acids with an average higher molecular weight than those in the oil administered. It is probable, therefore, that the lower fatty acids in the oil are partly absorbed as sodium salts.

113. ON THE UTILIZATION OF SYNTHETIC ETHYL ESTERS OF FATTY ACIDS

J. Muller and H. Murschhauser. Biochem. Z. 78, 63 (1916)

It is found that the dog can utilize the synthetic esters as well as the natural fats. It is shown that the fatty acids are resynthesized to neutral fat in the intestinal mucosa.

114. STUDY OF THE FOOD VALUE OF HYDROGENATED OILS

C. A. Pekarharing and W. Schut. Pharm. Weekblad 53, 769 (1916). C. A. 2758 (1916)

White rats, mice, and a dog were fed hydrogenated whale, peanut, sesame and cotton-seed oils. The fats were found harmless and were well absorbed.

115. UTILIZATION OF PALMITIC ACID, GLYCERYL PALMITATE, AND ETHYL PALMITATE BY THE DOG

J. F. Lyman. J. Biol. Chem. 32, 7 (1917)

With two dogs the following utilization values were obtained: lard, 96.7 and 96.5 per cent; ethyl palmitate, 58.8 and 50.9 per cent; glyceryl palmitate, 94.8 and 95.4 per cent; palmitic acid, 82.5 and 81.0 per cent.

Emulsified esters of fatty acids are not absorbed as such; absorption is limited by the rate of hydrolysis.

It is suggested that the melting point of the ester is not the only factor, probably not the chief factor, determining the rate of hydrolysis and absorption.

116. RELATIVE DIGESTIBILITY OF MAIZE OIL (CORN OIL), COTTONSEED OIL AND LARD

E. W. Rockwood and P. B. Sivickes. J. Am. Med. Assn. 71, 1649 (1918)

Experiments on dogs.	PER CENT OF FATS ABSORBED:
Corn oil	98.9
Cottonseed oil	98.8
Lard	97.8

117. THE ABSORPTION OF FATS

O. Cantoni. Boll. Soc. Ital. Biol. Sper. 3, 1278 (1928). C. A. 5224 (1929)

In a series of nine experiments on dogs, the fatty acid content of the portal as well as carotid blood was determined by the method of Bloor at various intervals after a diet of fatty substances was administered. Some typical results follow: 3 hours after meal, per cent fatty acid in the portal blood was 0.592, carotid 0.414; percent cholesterol, portal 0.109, carotid 0.131; after 24 hours, portal 0.642, carotid 0.638; cholesterol, portal 0.074, carotid 0.079. In all cases the fat content of the venous (C. A. says arterial) blood was higher, so the portal vein plays an important part in the absorption of fats; no definite conclusion could be drawn in regard to the cholesterol.

118. DIGESTION OF SYNTHETIC FATS

S. Suzuki. J. Agr. Chem. Soc. (Japan) 9, 1007 (1933). C. A. 2758 (1934)

Dogs digested triolein better than tristearin, the difference becoming more pronounced when large amounts were fed.

119. DIGESTION OF SYNTHETIC FATS

S. Suzuki and K. Nishino. J. Agr. Chem. Soc. (Japan) 10, 510 (1934). C. A. 6181 (1934)

Synthetic tripalmitin was given to dogs with the standard ration. The real digestive coefficient of tripalmitin ranks between those of triolein and tristearin.

120. THE ABSORPTION OF SOLUBLE, VOLATILE FATTY ACIDS

R. H. Huges and E. J. Wimmer. J. Biol. Chem. 108, 141 (1935)

The results of this experiment indicate that there is no increase in the amount of soluble, volatile fatty acids present in the thoracic lymph as glycerides during the process of digestion of fats which contain a soluble, volatile fatty acid such as butyric acid.

Dogs were anesthetised with nembutal. No data are presented to show the extent of fat absorption under the condition of the experiment. REICHERT-MEISSEL number was used for volatile fatty acid analysis.

121. INTESTINAL ABSORPTION OF VERY UNSATURATED FATS (LINSEED OIL) INTRODUCED THROUGH A FISTULA

U. Lombroso, L. Bellini and S. Fillippon. Boll Soc. Ital. Biol. Sper. 13, 177 (1938). C. A. 5468 (1938)

About 22% of the linseed oil was absorbed. The hypothesis is made that the amount

absorbed depends on the number of double bonds in the fat.

(See also Nos. 59, 109, 215, 216, and 481.)

4. Fowls

122. METABOLISM OF TRIBUTYRIN

Russell E. Davis. J. Biol. Chem. 83, 67 (1930)

The average digestibility of tributyrin as determined by seven trials with five hens was 86.9 per cent. If two second trials are excluded, the average of the first trials was 91.9%. The toxicity of tributyrin is believed to be the cause of the decrease in digestibility when the same hen is used for the second trial.

There was some storage of tributyrin in the depot fat when it was injected subcutaneously or intraperitoneally in rats.

No tributyrin was stored in the fat depot after tributyrin was fed. It is believed that the fat was transformed in part to higher fatty acids as it passed through the intestinal wall. The remainder probably was oxidized rapidly.

123. DIGESTION OF FAT BY FOWLS

K. Guntherberg. Wiss. Arch. Landw. Abt. 3, 339-67 (1930). C. A. 5451 (1931).

Fat balance experiments were conducted on chickens fed various diets. Fat is found in the feces even when a fat-free diet is fed; this fat must come from the body of the fowl. From 40 to 85% of the fat ingested, depending on the amount and kind of fat, is digested by fowls. These experiments show that fowls utilize fat quite as well as do other animals.

124. UTILIZATION OF FAT BY CHICKENS--A METHOD FOR DETERMINING THE ABSORPTION OF NUTRIENTS

D. Whitson, C. W. Carrick, R. E. Roberts and S. M. Hauge. Poultry Sci. 22, 137 (1943) -

Eighty to eighty-five per cent of the fat in the low fat diets was absorbed.

Ninety-four to ninety-five per cent of the fat in the high fat diet was absorbed.

(See also No. 314.)

5. Other Animals

125. A CONTRIBUTION TO FAT ABSORPTION FROM ISOLATED PIECES OF INTESTINE

Otto von Furth and J. Schutz. *Beit. Z. Chem. Physiol.* 10, 462 (1907)

Cats were used. The intestine was ligated at three places.

Fats, soaps and free fatty acids were only incompletely absorbed.

It is concluded that the preparations are not good enough to give significant conclusion.

126. DIGESTION OF FATS BY BULLOCKS

P. A. Seshan. *Indian J. Vet. Sci.* 2, 333 (1933). C. A. 4281 (1933)

Peanut meal, regisraw, and mature hay were fed. The unsaturated aliphatic acids were digested more completely than the saturated fatty acids.

127. THE CAUSES OF THE LAXATIVE ACTION OF CASTOR OIL

G. Valette and R. Salvanet. *Bull Sci. Pharm.* 43, 696 (1936). C. A. 2290 (1937)

Na ricinoleate has no influence on the denervated, devascularized intestine. The purgative action of the oil is exerted on the mucosa and is independent of the absorption of its constituents.

Other work by these authors on this subject is:

Compt. rend. soc. biol. 122, 68 (1936)

Compt. rend. soc. biol. 122, 150 (1936)

128. NUTRITIONAL REQUIREMENTS OF TROUT

C. M. McCay and A. V. Tunison. N. Y. (Cornell) *Agr. Exp. Sta.* 18th Ann. Rept. 76 (1936)

Trout when fed salmon oils, cottonseed oil, hydrogenated oil (crisco) at a 25% and a 7% level in the diet, utilized about 67% of the solid fat and 88% of the liquid fat.

129. THE EFFECT OF MELTING POINT OF FAT UPON ITS UTILIZATION BY GUINEA PIGS

C. M. McCay and H. Paul. *J. Nutr.* 15, 377 (1938)

Castor, soybeans, olive, coconut, salmon, codliver, neatsfoot, peanut butter, cottonseed, hydrogenated cottonseed, corn tallow, and lard were fed to guinea pigs at 6% of the diet.

The fecal lipids were found to be higher after feeding the higher-melting fats.

Oils (even castor oil) were found to be absorbed well.

130. THE UTILIZATION OF FATS BY HERBIVORA

H. Paul and C. M. McCay. *Arch. Biochem.* 1, 247 (1942)

Diets containing as much as 30% of fat can be fed to guinea pigs. The melting

point of a fat is important in determining its utilization by guinea pigs but not in the case of rabbits and sheep. Guinea pigs utilize only about half as much elaidic acid as oleic acid when these isomers are fed as 6% of the diet. Rats utilize the isomers equally well. In contrast to guinea pigs, rabbits and sheep digest and absorb hard fats as well as soft ones.

Rabbits resemble guinea pigs in being able to absorb castor oil.

Melting point rather than degree of saturation seems to be the determining factor in the utilization of fats by guinea pigs.

131. ABSORPTION OF ACETIC, PROPIONIC AND BUTYRIC ACIDS FROM THE ALIMENTARY CANAL

J. Barcroft, R. A. McAnally and A. T. Phillipson. *Biochem. J.* 38, iii (1944)

Volatile acids in blood leaving the gastrointestinal tract of pig, rabbit, horse, and sheep were determined. It was found among other things that the rate of absorption of sodium salts of acetic, propionic, and butyric acid from the rumen of the sheep decreases in this order.

(See also Nos. 59, 112, 114, 239 and 255.)

V. ABSORPTION OF CHOLESTEROL (132-161)

A. Digestibility

B. Cholesterolemia

A. Digestibility

132. ON THE RATE OF ABSORPTION OF CHOLESTEROL FROM THE DIGESTIVE TRACTS OF RABBITS

E. P. Lehman. J. Biol. Chem. 16, 495 (1914)

It is possible to demonstrate an increased blood cholesterol a few hours after the feeding of this substance.

133. THE ASSIMILATION OF CHOLESTEROL AND ITS ESTERS

J. H. Mueller. J. Biol. Chem. 22, 1 (1915)

1) Cholesterol is readily absorbed from the intestinal tract through the chyle and may be recognized in the contents of the thoracic duct.

2) When cholesterol is fed entirely in the free condition, a portion is esterified during the absorption and appears so in the chyle, and vice versa. Hence either in the intestinal contents or in the wall of the intestine, processes of esterification or of hydrolysis may take place which result in the absorption of the cholesterol in approximately the same proportion of free to ester found normally in the chyle.

3) This ratio seems not to be affected by the presence of small quantities of fatty acids in the food.

Esterification in other organs contributing to thoracic duct lymph is not excluded.

134. THE MECHANISM OF CHOLESTEROL ABSORPTION

J. H. Mueller. J. Biol. Chem. 27, 463 (1916)

The connection between bile and pancreatic secretions and the absorption of cholesterol in dogs is shown.

135. ON CHOLESTEROL METABOLISM

S. J. Thanhauser. Deut. Arch. Klin. Med. 141, 290 (1923)

Methods for cholesterol determinations are discussed and balance experiments on humans are performed.

136. ON THE INCREASED RATE OF ABSORPTION OF CHOLESTEROL IN THE PRESENCE OF DESOXYCHOLIC ACID

R. Schonheimer. Biochem. Z. 147, 258 (1924)

The literature is briefly reviewed.

It is shown that alimentary lipemia occurs in rabbits and guinea pigs after Na desoxycholic is added. Also the cholesterol content of rabbit serum is increased much more after feeding cholesterol and desoxycholic acid than without the latter.

137. ON THE EXCRETORY PATHWAYS FOR CHOLESTEROL

H. Beumer and F. Hepner. *Z. Exp. Med.* 64, 787 (1929)

Cholesterol in feces was measured on dogs (normal and bile fistula), rabbit and infant. It is concluded that most of the cholesterol is excreted in the feces. The excreted cholesterol is of dietary as well as of endogenous origin. The cholesterol from the bile is mostly reabsorbed from the intestine.

Bile markedly enhances the absorption of cholesterol.

138. ON EXCRETION AND REABSORPTION IN THE SMALL INTESTINE WITH SPECIAL REFERENCE TO THE STEROLS

R. Schoenheimer and L. Hrdina. *Z. Physiol. Chem.* 212, 161 (1932)

The intestinal secretion products of operated dogs were studied and compared with the fecal contents of these products. It was found that cholesterol and fatty acids are easily reabsorbed but that dihydrocholesterol is not.

139. THE FORMATION OF COPROSTEROL IN THE INTESTINE

H. Dam. *Biochem. J.* 28, 815 (1934)

A method is described for the determination of dihydrocholesterol in presence of coprosterol depending on the differential solubility of the corresponding digitonides in methyl alcohol. With its aid it is shown that dihydrocholesterol added to the diet is not converted into coprosterol but reappears unchanged in the feces.

140. THE ESTERIFICATION OF CHOLESTEROL DURING ABSORPTION FROM THE INTESTINE

E. Frolicher and H. Sullmann. *Biochem. Z.* 274, 21 (1934)

It was found that esterified as well as free cholesterol increases in the intestinal lymph of rabbits during the absorption of cholesterol. This proves that esterification of cholesterol takes place in the intestinal wall.

The cholesterol of intestinal lymph was also found to increase during the absorption of neutral fat.

141. A DIHYDROCHOLESTEROL BALANCE ON RATS

H. Dam and G. C. Brun. *Biochem. Z.* 276, 273 (1935)

Less sterol was excreted than was fed.

142. A DIHYDROCHOLESTEROL BALANCE EXPERIMENT ON THE RAT

H. Dam and George C. Brun. *Biochem. Z.* 276, 274 (1935)

The amount of dihydrocholesterol excreted was less than was ingested. After feeding a large amount of dihydrocholesterol the sterols in the body showed a higher degree of saturation.

143. CHOLESTEROL FEEDING AND FAT METABOLISM

R. P. Cook. *Biochem. J.* 30, 1630 (1936)

Cholesterol was absorbed by rats only when fat was present in the diet.

144. FAT FEEDING AND CHOLESTEROL ABSORPTION

R. P. Cook. *Biochem. J.* 31, 410 (1937)

Rats were used. The absorption of cholesterol contained in the diet was not increased when the fat concentration of the diet was raised.

145. THE MECHANISM OF FAT AND LIPOID ABSORPTION

C. Jimenez-Diaz, F. Bielchowsky and H. J. Castro-Mendoza. *Ann. Med.* 39, 449 (1936). *C. A.* 4383 (1937)

Cholesterol passes through the intestinal wall in a similar form as found in the blood; esterification occurs without the aid of the liver.

146. THE ABSORPTION OF STEROLS WITH PARTICULAR REFERENCE TO OSTREASTEROL

Warren M. Sperry and Werner Bergmann. *J. Biol. Chem.* 119, 171 (1937)

The sterol content of liver increased a little after feeding ostreasterol.

Since phytosterols are non-absorbable, ostreasterol is intermediate between them and cholesterol.

147. STEROL METABOLISM IN YOUNG WHITE RATS

H. C. Eckstein. *J. Biol. Chem.* 125, 107 (1938)

The negative sterol balances (fecal minus dietary sterols) of young white rats were 9.4 mg. per day on a 28 per cent fat diet and only 2.7 mg. per day on a 5 per cent fat diet.

The sterol content of the hair of rats was found to be independent of the diets fed.

(See also Nos. 161, 245, 301, 370, 371, 463 and 467.)

B. Cholesterolemia

148. THE ABSORPTION OF CHOLESTEROL FROM THE FOOD AND ITS APPEARANCE IN THE BLOOD

Charles Doree and J. A. Gardner. *Proc. Roy. Soc. B.* 81, 109 (1909)

It is stated that increased blood cholesterol after feeding may be due to increased bile flow, especially in animals that do not eat continually.

149. ON THE INHIBITORY ACTION OF THE SERA OF RABBITS FED ON DIETS CONTAINING VARYING AMOUNTS OF CHOLESTEROL ON THE HEAMOLYSIS OF BLOOD BY SAPONIN

Mary T. Fraser and J. A. Gardner. *Proc. Roy. Soc. B.* 81, 230 (1909)

When cholesterol given with the food of rabbits, some absorbed and finds its way into the blood stream as free cholesterol, only a portion of the total cholesterol, given in the food absorbed, the rest being excreted unchanged. The amount of cholesterol which finds its way into the blood stream was not increased in the experiment by increasing the amount given in the food. It would appear probable, therefore, that the animals only take up such an amount of cholesterol as they can utilize.

Cholesterol when in the form of esters undergoes hydrolysis in part, at any rate, during digestion and appears in the blood stream as free cholesterol.

When animals are fed on phytosterol, this substance is in part absorbed, just as in the case of cholesterol, and appears in the blood stream either itself or in the form of cholesterol. The latter point can, however, only be decided by the examination of very large quantities of the blood of animals fed on phytosterol.

150. THE ORIGIN AND DESTINY OF CHOLESTEROL IN THE ANIMAL ORGANISM. ON THE QUANTITY OF CHOLESTEROL AND CHOLESTEROL ESTERS IN THE BLOOD OF RABBITS FED ON DIETS CONTAINING VARYING AMOUNTS OF CHOLESTEROL

Mary T. Fraser and J. A. Gardner. *Proc. Roy. Soc. B.* 82, 559 (1910)

Digitonin is used to determine cholesterol.

After feeding cholesterol to rabbits, the levels of free and esterified cholesterol were increased in the blood.

Phytosterol is partially absorbed and produces an increase in blood cholesterol.

151. ON FAT AND LIPOID METABOLISM

K. Reicher. *Verhandl. der Deut. Kongr. f. Inn. Med.* 28, 327 (1911)

It is shown that lecithin and cholesterol ester levels increase in the blood during the absorption of triolein and peachpit oil.

152. CHEMICAL AND MORPHOLOGICAL INVESTIGATION ON THE SIGNIFICANCE OF CHOLESTEROL IN THE ORGANISM

L. Wacker and W. Hueck. *Arch. Exp. Path. u. Pharm.* 74, 416 (1913)

Feeding cholesterol to rabbits, calves, dogs, and horses raises the serum level of free cholesterol, but the cholesterol ester increases to a much greater extent (some-

times to 22 times the normal level).

153. THE ORIGIN OF CHOLESTEROL IN ALIMENTARY LIPEMIA

H. Beumer. Arch. Exp. Path. u. Pharm. 77, 375 (1914). Zentrbl. f. Physiol. 29, 459 (1914)

The theory of the reciprocal relation between serum and red blood cell cholesterol is disproved. Bile cholesterol is thought to be the source of plasma cholesterol in the hyperlipemia of dogs.

154. CHOLESTEROL AND ITS RELATION TO FAT METABOLISM

W. Hueck and L. Wacker. Biochem. Z. 100, 84 (1919)

In dogs and rabbits the blood level of cholesterol esters and phospholipids is markedly increased after feeding free cholesterol. Also, the cholesterol level is increased after feeding fat.

The significance of these finding is discussed.

155. ON EXPERIMENTAL CHOLESTEROL DISEASE IN RABBITS

R. Schonheimer. Virch. Arch. f. Path. Anat. 249, 1 (1924)

Alimentary hypercholesteremia is discussed, and it is claimed that the best method to produce it in rabbits is by feeding cholesterol dissolved in neutral fat.

156. ON THE FATE OF FOOD CHOLESTEROL AFTER ABSORPTION FROM THE INTESTINE

A. Miassnikow and B. Injinsky. Z. Exp. Med. 53, 100 (1926)

After feeding cholesterol in oil or eggs to rabbits the blood draining the duodenum contains more cholesterol. Also the liver shows an increased cholesterol content, but in the systemic circulation no increase in blood cholesterol is found.

It is proposed that cholesterol is at least partly absorbed by way of the portal vein and is retained in the liver.

157. THE ALIMENTARY HYPERCHOLESTEROLEMIA IN HEALTHY PEOPLE

M. Burger and H. Habs. Z. Exp. Med. 56, 640 (1927)

Cholesterol or cholesterol esters dissolved in oil and administered to men produces a pronounced hypercholesterolemia.

158. ALIMENTARY CHOLESTEROLEMIA

C. M. Leitece. Z. Exp. Biol. 6, 189 (1927)

159. ON STEROL ABSORPTION AS MEASURED ON PORTAL BLOOD

D. Yuasa. Z. Physiol. Chem. 185, 116 (1929)

When triolein and cholesterol are administered to dogs the cholesterol content of portal blood is increased, whereas in the case of sitosterol a decrease in the cholesterol of portal blood is found.

159A. THE BEHAVIOR OF PHOSPHATIDES AND CHOLESTEROL IN WHOLE BLOOD, PLASMA AND ERYTHROCYTES OF HEALTHY PEOPLE AFTER FEEDING OLIVE OIL WITH OR WITHOUT PHOSPHATE

H. Wendt. *Biochem. Z.* 250, 212 (1932)

Phospholipids and cholesterol increase only in plasma. Phosphates do not change the general picture.

159B. PSORIASIS. II. EFFECT OF ADMINISTRATION OF CHOLESTEROL (TOLERANCE TEST) ON THE LIPIDE PARTITION AND THE ALBUMIN-GLOBULIN RATIO

I. Rosen, H. Rosenfeld and F. Krasnow. *Arch. Dermatol. Syphilol.* 35, 1093 (1937).
C. A. 7514 (1937)

The cholesterol of plasma was found lower than average for the more severe cases. No other significant variations from normal were found.

160. EXPERIMENTAL HYPERCHOLESTEREMIA IN DOGS

W. C. Corwin. *Arch. Path.* 26, 456 (1938)

A high fat diet may or may not produce hypercholesteremia. Lecithin of adrenal origin when added to the diet gives a sustained cholesteremia.

Cholesterol and sodium cholate have no effect when administered by capsule in the solid state.

161. THE INFLUENCE OF DIET ON THE CHOLESTEROL CONCENTRATION OF THE BLOOD SERUM IN NORMAL, SPAYED, AND HYPOTHYROID MONKEYS

W. M. Sperry, J. W. Jailer and E. T. Engle. *Endocrinol.* 35, 38 (1944)

A single feeding of several eggs did not change the serum cholesterol. Egg feeding for four days raised the serum level. On the fifth day combined cholesterol increased proportionally more than free cholesterol.

Cholesterol emulsion given for four days did not increase serum cholesterol, but cholesterol dissolved in oil did. Four-day egg-phosphatide feeding did not increase serum cholesterol.

(See also Nos. 117, 132, 165, 301, 303, 320, 433, 434, 484, 486, 490, 495, 501, 514, 516, 518, 522, 523, 528, 533, 537, 547, 549, 550, 551, 553, 555, 588, 589, and 591).

VI. ABSORPTION OF FAT-LIKE SUBSTANCES

(162-172)

162. ON THE THEORY OF FAT ABSORPTION

W. Connstein. Arch. f. Anat. Physiol. pg. 30 (1899)

Lanolin was fed to a dog. Nearly all of it was excreted. The melting point of the lanolin was 42° C.

It is concluded that hydrolysis prior to absorption is essential.

163. ON THE QUESTION OF FAT ABSORPTION

V. Henriques and C. Hausen. Z. f. Physiol. 14, 313 (1900)

Paraffin, fat and a trace of fatty acid were shaken with dilute Na₂CO₃ solution. A fine emulsion of the fat and the paraffin, was obtained and fed to rats. Under these conditions the fat was absorbed but the paraffin was excreted in the feces.

164. ABSORPTION OF FAT-LIKE SUBSTANCES OTHER THAN FATS

W. R. Bloor, J. Biol. Chem. 15, 105 (1913)

Hydrocarbons and unsaponifiable esters (wool-fat) were fed to dogs and it was found that none of them were absorbed. It is assumed that only fatty substances that can be brought in a water soluble shape can be absorbed.

The lymph was collected while the animals were under anesthetic, but it is pointed out that the anesthesia interfered with the absorption of fats,

165. EXPERIMENTS WITH THE UNSATURATED HYDROCARBON, SQUALENE (SPINACENE)

H. J. Channon. Biochem. J. 20, 400 (1926)

When the unsaturated hydrocarbon squalene (spinacene) C₃₀H₅₀ is included in the diet of the rat, some absorption occurs.

The amount of cholesterol present in the liver increases by about 100 o/o.

The increase in the amount of unsaponifiable matter in the liver is not wholly accounted for by the presence of squalene and the increase in cholesterol.

166. THE UNSAPONIFIABLE FRACTION OF LIVER OILS

H. J. Channon and G. A. Collinson. Biochem. J. 23, 676 (1929)

The iodine value of the non-sterol fraction of the unsaponifiable matter of the livers of rats which receive liquid paraffin in their diet was found to be 31, as against 119 for that from the control animals. This result suggests that liquid paraffin is absorbed to some extent.

This was confirmed by an experiment on pigs, in which the hydrocarbon was isolated from the liver.

167. CAN SATURATED STEROLS BE ABSORBED? REMARKS ON THE BEHAVIOUR OF THE LYMPH OF THE THORACIC DUCT DURING FAT AND STEROL ABSORPTION
H. V. Behring and R. Schonheimer. *Z. physiol. Chem.* 192, 97 (1930). C. A. 324 (1931)
Saturated sterols are not absorbed from the digestive tract of mice or dogs.
168. THE ABSORPTION OF n-HEXADECANE FROM THE ALIMENTARY TRACT OF THE RAT
Mohammed Abdel Hamid El Mahdi and Harold John Channon. *Biochem. J.* 27, 1487 (1933)
Synthetic n-hexadecane was administered to rats for 20-25 days. Absorption (measured as ingestion minus excretion) was found to be 50-100 mg./1 day. After sacrificing the animal only small amounts were found in the carcass and viscera so it is suggested that some hexadecane was metabolized.
169. THE ABSORPTION OF n-HEXADECANE FROM THE ALIMENTARY TRACT OF THE CAT
H. J. Channon and J. Devine. *Biochem. J.* 28, 467 (1934)
A cat absorbed 28.14 g. of n-hexadecane when 33.64 g. were administered to it in cream over a period of 29 days. The animal can metabolize n-hexadecane.
Consideration of the iodine values and cholesterol contents of the unsaponifiable fractions prepared from the different tissues suggested that hexadecane was generally present in them. Its distribution in the tissues appears to be related to their fat content.
170. ABSORPTION OF LIQUID PETROLATUM (MINERAL OIL) FROM THE INTESTINE
W. A. Stryker. *Arch. Path.* 31, 670 (1941)
A histologic and chemical study is presented.
An extensive review of the literature is given. From the experiments on rats and human autopsy material it is concluded that liquid petrolatum is absorbed from the intestine in small amounts.
171. EMULSIFICATION AND ABSORPTION OF FATS AND PARAFFINS IN THE INTESTINE
A. C. Frazer and H. Stewart. *Nature* 149, 167 (1942)
The absorption of emulsified paraffin is shown by three methods:
1) Histological - staining with Sudan.
2) Biochemical - 60% of the administered dose being absorbed.
3) Chylomicrograph similar to the one obtained in the absorption of olive oil.

172. METABOLISM OF A PARAFFIN

DeWitt Stetten, Jr. J. Biol. Chem. 147, 327 (1943)

A hexadecane containing deuterium was fed to rats, and it was shown that this compound is very efficiently absorbed from the gastrointestinal tract and that much of it is oxidized to fatty acid in the body.

(See also Nos. 239, 286 and 488.)

VII. EXTRINSIC FACTORS INFLUENCING FAT ABSORPTION
(173-207)

- A. Vitamins
- B. Diet (high fat, mixed, etc.)
- C. Phlorizin, Monoiodoacetic Acid
- D. Other factors (quinine, anoxia, fatty acid deficiency, etc.)

A. Vitamins

173. VITAMINS, EXPOSURE TO RADIUM AND INTESTINAL FAT ABSORPTION

J. C. Mottram, W. Cramer, and A. H. Drew. Br. J. Exp. Path. 3, 179 (1922)

A histological study of the factors influencing fat absorption was made. Lack of vitamins A and B gave an abnormal histological picture.

174. AVITAMINOSIS AND THE DIGESTIVE ORGANS

H. E. Never. Arch. Physiol. Pflug. 224, 787 (1930). C. A. 5801 (1930)

Vitamin deficiency in dogs led to a delayed fat absorption, a diminished secretion of the digestive juices, and reduced peristalsis.

175. FAT DIGESTION IN NORMAL AND RACHITIC PERSONS AFTER TREATMENT WITH IRRADIATED ERGOSTEROL

V. Rossi. Clin. Ped. 12, 809 (1930)

176. THE EFFECTS OF VITAMIN DEFICIENCY UPON THE COEFFICIENT OF DIGESTIBILITY OF PROTEIN, FAT AND CARBOHYDRATE

R. Reder St. Julian and V. G. Heller. J. Biol. Chem. 90, 99 (1931)

The metabolism of rats in a diet deficient in a given vitamin has been compared with that of animals on the same diet supplemented with the missing vitamin. Vitamins A, B, B₂, C and D were studied. The coefficient of digestibility of protein, fat and carbohydrate were not affected by the deficiencies.

178. THE SPARING ACTION OF FAT ON VITAMIN B

H. M. Evans and S. Lepkovsky. J. Biol. Chem. 96, 179 (1932)

Fat absorption was measured on rats fed mixed diets with added fat and with or without yeast.

Added Fat	per cent. absorbed	
	without yeast	with 1 gm. yeast
Stearin	43.8	40.0
Palmitin	84.2	73.4
Myristin	93.5	91.0
Laurin	97.5	96.0
Caprin	98.0	96.5
Caprylin	99.0	97.5
Ethyl palmitate	87.0	76.4
Ethyl stearate	56.2	55.0
Cottonseed oil	97.0	95.5

Note that ethyl stearate, though having a low melting point, was still poorly absorbed.

179. THE ABSORPTION OF NITROGEN AND OF FAT FROM THE ALIMENTARY CANAL OF RATS KEPT ON A VITAMIN A DEFICIENT DIET

M. M. Sampson, M. Dennison and V. Korenchevsky. Biochem. J. 26, 1315 (1932)

Two vitamin A deficient rats were compared with two normals. All came from the same litter. The fat in the feces was determined. The four rats showed the same amount of non-absorbed fat in the feces. Each rat was subjected to four determinations. The results of the analysis checked very well in all the rats. Only in the last stage of the observation did the absorption of fat decrease appreciably.

180. ON HISTOLOGICAL FINDINGS AFTER OVERDOSAGES OF VITAMIN A CONCENTRATE

G. Domagk and P. V. Dobeneck. *Virch. Arch. f. Path. Anat.* 290, 385 (1933)

Vitamin A enriched oil is absorbed much faster by rats than the same oil without the vitamin A.

This holds for sesame oil, peanut oil and paraffin oil.

181. FAT METABOLISM IN VITAMIN A DEFICIENCY--THE UTILIZATION OF FAT AND THE DESATURATION OF FAT IN THE LIVER

H. N. Green. *Biochem. J.* 28, 25 (1934)

Large amounts of fat can be absorbed by the rat in the absence of vitamin A from the diet.

182. THE INFLUENCE OF VITAMINS A, B OR D. ANEMIA OR FASTING UPON THE RATE OF FAT ABSORPTION IN THE RAT

Margaret House Irwin, H. Steenbock and A. R. Kemmerer. *J. Nutr.* 12, 357 (1936)

No specific effects of vitamins on fat absorption were found. The addition of vitamins A, B, D had no effect upon the rate of absorption in normal rats.

Avitaminotic A, B, D animals, anemic animals, fasted (6 days) animals, and those fed a limited quantity of a complete diet all showed a less rapid fat absorption than normal animals.

It may well be that the decrease in fat absorption in the avitaminotic animals is due to the nutritional state of the animals as a whole and not to any specific vitamin deficiency.

183. THE RESORPTION OF FATS IN C-AVITAMINOSIS

E. I. Kleitman. *J. Physiol. (USSR)* 25, 536, 539 (1938)

The resorption of fats is unchanged during experimental vitamin C-avitaminosis.

184. ACTION OF NICOTINAMIDE IN DISTURBANCES OF FAT ABSORPTION

H. Siedek and L. Reuss. *Wien. Klin. Wochschar* 52, 432 (1939). *C. A.* 4117 (1940)

A patient with pellagra was found to have deficient fat absorption. Nicotinamide administration reduced the fat content of feces to within normal limits.

184 A. THE BEHAVIOR OF LIPASES IN EXPERIMENTAL RICKETS

A. Liotta and L. Bellini. *Pathologica* 33, 343 (1941). C. A. 3521 (1946)

No difference was found between the lipolytic activity of normal and rachitic albino rats. It is supposed that the decreased absorption of the fats in experimental rickets is not caused by changes of the digestive activity but by an alteration of the fat metabolism in the tissues.

(See also Nos. 236, 274, 412, and 454.)

B. Diet (high fat, mixed, etc.)

185. GROWTH EXPERIMENTS ON DIETS RICH IN FAT

H. Levine and A. H. Smith. J. Biol. Chem. 72, 223 (1927)

The rat can utilize from 98 to 99 per cent of the ingested fat (lard) on a high-fat diet. This is in agreement with the results of Drummond, J., Biochemical Journal 13, 95 (1919).

186. ABSORPTION OF FAT IN RATS ON VARIOUS HIGH FAT DIETS

H. Levine and A. H. Smith. J. Biol. Chem. 72, 235 (1927)

It is shown that rats can utilize fat almost completely (98-99%) even when the fat content of the diet amounts to 86% of the total calories ingested.

187. FAT METABOLISM

E. H. MacArthur. J. Biol. Chem. 87, 299 (1930)

Experiments were carried out on white rats and women. Digestion curves, based on chylomicron count of blood, show that butter and cod liver oil are taken up faster when fed alone than when fed with bran.

188. THE INFLUENCE OF QUALITATIVELY DIFFERENT FOODS ON THE RESORPTION OF THE BASIC FOOD MATERIALS--PROTEIN, FAT, CARBOHYDRATE AND SALTS

V. V. Lavrov, A. V. Lyslova and M. V. Filippova, Trudy Vsesoyuz. Inst. Eksptl. Med. 1, 19 (1936). C. A. 7489 (1937)

189. THE DIGESTIBILITY OF FOOD WITH DUCKS

A. G. Troitzkaya, A. K. Danilova and K. S. Palmova. Biedermanns Zentr. B. Tierernahr 8, 69 (1936). C. A. 134 (1937)

Sorghum and maize added to the main ration increase fat digestibility; oats, barley, and potatoes decrease it.

190. MOLASSES REDUCES DIGESTIBILITY OF OTHER COMPONENTS OF RATIONS

H. M. Briggs, V. G. Heller and R. Wall. Okla. Agr. Exp. Sta. Biennial Rept. pg. 62 (1938-40). C. A. 2938 (1941)

Fat digestibility for lambs was lowered 17-18.3% by the addition of molasses to corn-alfalfa hay ration.

191. APPARENT DIGESTIBILITY OF CARBOHYDRATES, FATS, AND "INDIGESTIBLE RESIDUE" IN WHOLE WHEAT AND WHITE BREADS

R. R. Sealock, D. H. Basinski and J. R. Murlin. J. Nutr. 22, 589 (1941)

It may be concluded that under the conditions of these experiments in which the diet furnished approximately adequate calories for maintenance of weight of each subject, the higher "indigestible residue" of the whole wheat products does not interfere with the digestion and absorption of carbohydrate and fat.

192. THE INTERRELATION OF CALCIUM AND FAT UTILIZATION IN THE GROWING ALBINO RAT

C. E. French. J. Nutr. 23, 375 (1942)

Fat utilization was measured in rats while the dietary constituents were varied.

A high carbohydrate, low fat, low calcium diet produced the poorest utilization of fat.

193. THE EFFECT OF ADDED GLUCOSE UPON THE DIGESTIBILITY OF FIBER IN RATIONS FOR SHEEP

T. S. Hamilton. J. Nutr. 23, 101 (1942)

Added corn sugar in the ration did not affect the apparent gross energy or the digestibility of either ether extract.

194. BALANCE STUDIES IN HYPOPHYSECTOMIZED AND NORMAL RATS FED ON EQUICALORIC HIGH CARBOHYDRATE AND HIGH FAT DIETS

L. T. Samuels, R. M. Reinecke and H. A. Ball. Endocrinol. 31, 35 (1942)

The fat-fed controls absorbed 93.2% of the administered fat over the balance period, whereas the fat-fed hypophysectomized animals absorbed 89.1%.

195. THE INFLUENCE OF THE PROTEIN CONTENT OF THE DIET UPON FAT DIGESTIBILITY

Richard H. Barnes, Margaret F. Primrose and George O. Burr. J. Nutr. 27, 179 (1944)

Rats receiving diets containing 14 to 30% protein showed a lower fat digestibility on the lower protein diets; the absorption of the poorly digestible fats was especially affected by changes in the protein content of the diet. The importance of standardizing the basal diet for comparing all measurements of fat digestibility is stressed.

(See also Nos. 65, 75, 84, 91, 93, 97, 104, 124, 147, 161, 297, 310, 321, 338, 469, 479, 482 and 531.)

C. Phlorizin, Monoiodoacetic Acid

196. THE ACTION OF MONOiodoacetic acid ON DIASTASE, LIPASE AND PEPSIN

F. Barth. *Biochem. Z.* 270, 63 (1934)

In vitro it is found that a concentration of monoiodoacetic acid, which is 20 to 30 times as high as the one that inhibits fat absorption in vivo, does not delay the action of these enzymes.

197. THE INHIBITION OF FAT RESORPTION BY PHLORIZIN

F. Verzar and L. Laszt. *Biochem. Z.* 276, 1 (1934)

Phlorizin is not found to be toxic in large doses like monoiodoacetic acid. The latter is found to inhibit absorption in short-time experiments. Rats were used. Urethan narcosis slows the emptying of the stomach. Narcosis has no direct influence on the absorption from the intestine. Phlorizin completely inhibits absorption of food or injected olive oil or lard only during the first 6-8 hours. Thereafter absorption goes on slowly, even if more phlorizin is administered.

It is suggested that the accelerating factor in fat absorption, namely the phosphorylation before synthesis into neutral fat, is inhibited by phlorizin so that after phlorizin administration fatty acids are absorbed only by simple diffusion.

198. ABSORPTION IN PHLORIZINIZED ANIMALS. I. ABSORPTION OF FATS

G. Sarzana. *Boll. Soc. Ital. Biol. Sper.* 10, 197 (1935). C. A. 5649 (1936)

Fat excretion in the feces of pigeons given high doses of phlorizin increases, but the percentage of fat absorbed is not displaced considerably.

199. MICROSCOPIC INVESTIGATIONS CONCERNING FAT RESORPTION IN THE NORMAL INTESTINE AND DURING INHIBITION OF THE FAT RESORPTION BY MONOiodoacetic acid AND PHLORIZIN

L. Jeker. *Arch. Physiol. Pflug.* 237, 1 (1936)

Different methods for staining fats are discussed, and a short historical review is given. Sudan is used for total fats and the Fischler method employed for fatty acids. The intestine of the rat is studied.

200. THE EFFECT OF MONOiodoacetic acid ON THE INTESTINAL ABSORPTION OF MONOSACCHARIDES AND SODIUM CHLORIDE

K. A. Klinghoffer. *J. Biol. Chem.* 126, 201 (1938)

The injection of monoiodoacetic acid causes a decreased absorption of glucose, xylose, and sodium chloride from the intestinal tract of the rat. This decrease is associated with severe intestinal pathology and is probably caused by it, rather than by any specific action of the drug on intestinal phosphorylation.

201. INFLUENCE OF PHLORIZIN ON ABSORPTION OF NEUTRAL FATS

S. Filippin and L. Bellini. *Boll. Soc. Ital. Biol. Sper.* 13, 178 (1938). C. A. 5070 (1938)

Phlorizin diminished the absorption of triolein introduced into dog intestine by fistula.

202. THE ABSORPTION OF FAT ACID AND NEUTRAL FAT IN NORMAL AND PHLORIZIN-
POISONED DOGS

S. Fillippon and L. Bellini. Arch. di Fisiol. 38, 220 (1938). C. A. 4323 (1939)

The decrease in fat absorption caused by phlorizin appears to bear no relation to its effect on sugar excretion.

(See also Nos. 261, 265, 378, 408, 416, and 576.)

D. Other Factors (quinine, anoxia, fatty acid deficiency, etc.)

VIII. ROLE OF THE STOMACH IN FAT ABSORPTION (208-235)

A. Importance in Fat Absorption

B. Gastric Inhibition by Fats

A. Importance in Fat Absorption

203. THE FAT ABSORPTION IN THE IRRITATED INTESTINE

R. Mahler and W. Nonnenbruch. *Z. Exp. Med.* 85, 112 (1932)

Rats fed paprika show increased absorption of fat, according to histological studies.

204. HYPERMOTILITY OF THE SMALL INTESTINE WITH IMPAIRED FAT DIGESTION

D. Adlersberg. *Rev. Gastroenterol.* 4, 28 (1937)

The feces contain large amounts of fatty soaps, which diminish after opium administration.

205. FAT ABSORPTION IN ESSENTIAL FATTY ACID DEFICIENCY

Richard H. Barnes, Elmer S. Miller and George O. Burr. *J. Biol. Chem.* 140, 773 (1941)

Methyl esters of conjugated corn oil fatty acids were fed to rats. Absorption rate of fat per unit of body size is the same in cured and fatty-acid-deficient rats.

The evidence for the decreased incorporation of labeled fatty acids into the intestinal mucosa phospholipids of deficient rats seems rather poor.

206. EFFECT OF QUININE ON THE ABSORPTION OF FAT

A. Roy and P. B. Sen. *Ann. Biochem. and Exp. Med.* 3, 9 (1943). *C. A.* 1566 (1944)

Quinine markedly decreases the absorption of neutral fat by normal rats when it is introduced into the intestine. Fatty acids are also absorbed to a slightly less extent. It is concluded that quinine interferes with the activity of the lipase.

207. THE EFFECT OF ANOXIA ON FAT ABSORPTION IN RATS

P. L. McLachlan and C. Woodrow Thacker. *Am. J. Physiol.* 143, 391 (1945)

Corn oil was fed by stomach tube. No correlation was found between fat absorption under normal circumstances and sex or body weight of the rat. Low O₂ pressures 63, 53 mm. Hg, produced a lower fat absorption. There is evidence (Van Liere, 1941) that anoxia produces decreased motility of the stomach and intestine and also prolongs the emptying time.

(See also Nos. 473, 477, 488 and 517.)

208. THE ABSORPTION OF FAT BY THE STOMACH

O. Weiss. Arch. Physiol. Pflug. 144, 540 (1912)

Young dogs and cats fed milk showed fat droplets in the wall of the stomach. When fed albumin no such droplets were observed.

209. EVIDENCE OF FAT ABSORPTION BY THE MUCOSA OF THE MAMMALIAN STOMACH

C. W. Greene and W. F. Skaer. Am. J. Physiol. 32, 358 (1913)

The gastric epithelium of rats, cats, and dogs shows a definite cycle of variation in fat content following a meal rich in fat.

The epithelial fat content following a meal of fat is described by a curve which at first shows a slight drop, then a rapid rise in the amount of fat in the cells, followed by a more gradual and slow decline to the normal.

The fat content was determined by histological methods.

210. THE QUESTION OF FAT ABSORPTION FROM THE MAMMALIAN STOMACH

L. B. Mendel and E. J. Baumann. J. Biol. Chem. 22, 165 (1915)

Dogs and cats were anesthetized and the pylorus end of the stomach was ligated. No lipemia was observed after the introduction of peanut oil. Fat droplets were found in the mucosa of the stomach.

It is concluded that no absorption by way of the stomach takes place.

211. EXPERIMENTAL RESEARCHES ON THE ABSORPTION OF FAT IN THE STOMACH

S. Hirayama. Japan Med. World 2, 101 (1922)

A histological examination shows that the stomach mucosa absorbs fat in the following animals: cat, rat, dog, guinea pig, tortoise, frog, and water-lizard.

212. THE QUESTION OF FAT ABSORPTION FROM THE MAMMALIAN STOMACH

T. Inouye. Am. J. Physiol. 69, 116 (1924)

In experiments on dogs it has been demonstrated that when fat is introduced into a stomach ligated at the pylorus, some of it may pass through the stomach wall and appear in the lymph of the thoracic duct after a prolonged time. The amount of fat ordinarily absorbed in this way is so small as to be almost negligible in the consideration of fat transport in the organism.

213. THE ABSORPTION OF FATS AND LIPOIDS IN THE PLAICE

B. Dawes. J. Marine Biol. Assn. (United Kingdom) 75, 102 (1930). C. A. 542 (1931)

There is an increase in the fat content of the superficial epithelium of the fish stomach 30-50 hours after gastric digestion.

Fat absorption is transferred from the stomach to the postpyloric intestine when the frequency of feeding is increased.

(See also Nos. 244, 348, 460 and 562.)

B. Gastric Inhibition by Fats

214. THE PASSAGE OF FOODSTUFFS FROM THE STOMACH

W. B. Cannon. *Am. J. Physiol.* 12, 387 (1904)

The rate at which different fats leave the stomach was studied in cats.

215. ON THE IMPORTANCE OF THE MELTING POINT OF FATS FOR THE STOMACH EMPTYING TIME

F. Tangl and A. Erdelyi. *Biochem. Z.* 34, 94 (1911)

It is shown on dogs that emulsified fats leave the stomach more slowly when their melting points are higher or their viscosities greater.

216. INFLUENCE OF THE MELTING POINT OF NON-EMULSIFIED FATS ON THE STOMACH EMPTYING TIME

A. von Fejer. *Biochem. Z.* 53, 168 (1913)

In dogs it was found that emptying of the stomach takes longer the higher the melting point and the greater the viscosity of the fat.

217. THE PYLORUS REFLEX AND FAT IN THE DUODENUM

W. Tonnis and H. E. Never. *Arch. Physiol. Pflug.* 207, 24 (1925)

In dogs it is shown that neutral fat does not affect the closure of the pyloric sphincter but that fatty acid does. Other acids also close the sphincter.

218. ON THE MECHANISM OF THE INHIBITION OF GASTRIC SECRETION BY FAT

T. P. Feng, H. C. Hou and R. K. S. Lim. *Chinese J. Physiol.* 3, 371 (1929)

The ingestion of fat causes inhibition of the secretion of completely denervated (auto-transplanted) gastric pouches.

This not only indicates that the extrinsic nerves are unessential for inhibition but definitely implies a humoral mechanism.

The intravenous injection of thoracic lymph collected after a fat meal does not inhibit gastric secretion, nor does the institution of a lymph fistula, so that the chyle no longer drains into the circulation, affect the course of secretion.

Thus fat itself is not the inhibitory agent, nor is the agent transmitted through lymphatic channels.

Dogs were used.

219. RATE OF EVACUATION OF VARIOUS FOODS FROM THE NORMAL STOMACH

M. J. Wilson, W. H. Dickson and A. C. Singleton. *Arch. Int. Med.* 44, 788 (1929)

The initial emptying of the stomach depends on two factors: the presence of peristalsis of adequate depth and the consistency of the meal.

In the case of fats this delay is associated with shallower peristaltic waves, possibly because of depression of muscular activity by products of fat digestion circulating in the blood.

220. DEMONSTRATION OF THE HUMORAL AGENT IN FAT INHIBITION OF GASTRIC SECRETION

T. Kosaka and R. K. S. Lim. *Proc. Soc. Exp. Biol. and Med.* 27, 890 (1930)

It is shown that an inhibitory agent may be formed in the mucosa of the small and large intestine.

221. ON THE MECHANISM OF THE INHIBITION OF GASTRIC SECRETION BY FAT. THE ROLE OF BILE AND CYSTOKININ

T. Kosaka and R. K. S. Lim. *Chinese J. Physiol.* 4, 213 (1930)

Bile is not the humoral inhibitory agent in fat inhibition of gastric secretion. A sample lot of Ivy's cystokinin caused definite inhibition of gastric secretion to a meal when injected intravenously in doses of about 5 mg. per kg. This suggests that cystokinin may include or may actually be the chalone for gastric secretion.

Dogs were used.

222. THE EFFECT OF OILS ON GASTRIC SECRETION AND MOTILITY

W. M. Roberts. *Quart. J. Med.* 24, 133 (1931)

The less saturated oils seem more efficient in inhibiting gastric secretion. Fatty acids also show inhibitory properties.

The action of oil is exerted mostly or entirely after it has left the stomach. Tests were made on humans.

223. PYLORIC REFLEXES IN HUMANS

F. Brauch. *Arch. Physiol. Pflug.* 229, 694 (1932)

The delay of stomach emptying time after fat is introduced is explained by an inhibition of the stomach movements. It is shown however by measurements on humans that fat does not close the pyloric sphincter.

224. ON THE MECHANISM OF THE INHIBITION OF GASTRIC SECRETION BY FAT A GASTRIC-INHIBITORY AGENT OBTAINED FROM THE INTESTINAL MUCOSA

T. Kosaka, R. K. S. Lim, S. M. Ling and A. C. Liu. *Chinese J. Physiol.* 6, 107 (1932)

225. ON THE REGULATING ACTION OF THE PANCREAS FOR THE STOMACH EMPTYING AFTER A FATTY MEAL

M. Nothmann and H. Wendt. *Arch. Exp. Path. U. Pharm.* 168, 49 (1932)

In depancreatized dogs it is found that the stomach is emptied very rapidly after a fat meal. This is not corrected by insulin.

In duct ligated dogs the stomach emptying is retarded as in the normal dog.

It is concluded that the pancreas normally plays a part in the delay of stomach emptying after a fatty meal, but it cannot be said whether this is a nervous or hormonal control.

The rapid emptying of the stomach of the depancreatized dog must be disadvantageous for fat absorption.

226. ON THE MECHANISM OF THE INHIBITION OF GASTRIC SECRETION BY FAT. THE ROLE OF 'GLUCOSE, INSULIN AND THE PARASYMPATHETIC SYSTEM

Mao-Chih Li. Chinese J. Physiol. 8, 37 (1934)

Both fat and the intestinal extract "enterogastrone" can inhibit gastric secretion induced by several means; viz, meal, histamine, insulin and sham-feeding.

Both inhibit without causing any specific change in the blood sugar so that they clearly do not utilize the central parasympathetic inhibitory mechanism described by La Barre and Cespedes.

Whether a nervous reflex plays any role in fat inhibition cannot be determined.

227. THE EFFECT OF FAT ON GASTRIC MOTILITY

B. A. McSwiney and W. R. Spurrell. J. Physiol. 84, 41 (1935)

The degree of gastric delay produced by fats increases with their concentration in the meal.

Delay is produced as the result of some direct action of the fat within the stomach.

Fat in the duodenum can produce gastric delay, but the extent of this effect must be governed by intragastric conditions.

228. INHIBITING ACTION OF FATS ON GASTRIC SECRETION PROVOKED BY HISTAMINE

B. Fierens and P. P. De Nayer. Compt. rend soc. biol. 122, 805 (1936). C. A. 7215 (1936)

Dogs with gastric fistulae were used.

Peanut oil decreased gastric secretion to half the secretion in the fasting state.

229. THE GASTRIC EVACUATION OF FATS WITH ESPECIAL REFERENCE TO THE PYLORIC SPHINCTER ACTIVITY

J. P. Quigley and I. Meschan. Rev. Gastroenterol. 4, 272 (1937)

The tone and motility of the stomach, the pyloric sphincter and duodenum are depressed by natural fats and their digestion products. By the balloon method it was shown that the sphincter relaxes and therefore it is not responsible for the retarded gastric evacuation after fat feeding.

230. THE ROLE OF THE UPPER SMALL INTESTINE IN THE CONTROL OF GASTRIC SECRETION: THE EFFECT OF NEUTRAL FAT, FATTY ACID AND SOAPS: THE PHASE OF GASTRIC SECRETION INFLUENCED AND THE RELATIVE IMPORTANCE OF THE PSYCHIC AND CHEMICAL PHASES

H. Shay, J. Gershon-Cohen and S. S. Fels. *Ann. Int. Med.* 13, 294 (1939)

In eight patients it was shown that neutral fats, fatty acids and soaps when instilled into the duodenum simultaneously with a mouth meal depress gastric secretion. Afterwards a sharp secondary rise in secretion was noticed.

The gastric motor mechanism appears to have a lower threshold than the secretory mechanisms.

231. THE INFLUENCE OF FATS ON THE MOTOR ACTIVITY OF THE PYLORIC SPHINCTER REGION AND ON THE PROCESS OF GASTRIC EVACUATION STUDIED BY THE BALLOON-WATER MANOMETER AND BY THE OPTICAL MANOMETER-FLUOROSCOPIC TECHNIQS

J. P. Quigley, J. Werle, E. W. Ligon, M. R. Read, K. H. Radzow and I. Meschan. *Am. J. Physiol.* 134, 132 (1941)

Cream in the duodenum is shown to inhibit the pyloric region.

232. INHIBITION OF THE PYLORIC SPHINCTER REGION BY THE DIGESTION PRODUCTS OF FAT

J. P. Quigley and I. Meschan. *Am. J. Physiol.* 134, 803 (1941)

Studies made with the tandem balloon method demonstrated that the introduction of fatty acids or soaps into the proximal intestine of fasting dogs inhibited the motility of the pyloric antrum, sphincter and duodenal bulb in a manner similar to that produced by natural fats. However, the evidence indicated that if natural fats were administered, they initiated the inhibition and the digestion products continued this influence.

233. THE EFFECT OF A CREAM MEAL ON THE ACIDITY AND NEUTRALIZING ABILITY OF THE CONTENTS OF THE DUODENAL BULB IN NORMAL DOGS

J. E. Berk, J. E. Thomas and M. E. Reh fuss. *Am. J. Physiol.* 136, 285 (1942)

Cream diminishes the acidity of the duodenal bulb; this is only partly due to the inhibition of gastric secretion.

234. THE RELATION BETWEEN THE CHEMICAL STRUCTURE OF FATS AND THEIR ABILITY TO PRODUCE GASTRIC INHIBITION

H. C. Tidwell and E. S. Cameron. *Bull. Johns Hopkins Hosp.* 70, 362 (1942)

Experiments in animals and in a human subject indicate that the gastric inhibitory response to fat varies with the chemical composition of the fat. There is a striking parallelism between the ease of absorption of a fat and its ability to produce gastric inhibition, which suggests that absorption of some fat from the duodenum is a prerequisite for the liberation of enterogastrone.

235. THE EFFECT OF FAT ON THE GASTRIC RESPONSES TO FOODS

J. A. Killian and N. E. Marsh. Oil and Soap 22, 250 (1945)

Humans were fed meals into which moderate amounts of fat were incorporated. No relation was found between the fat content of the meal and the stomach emptying time, if the amounts of fat in the diet were not excessive.

(See also Nos. 76, 318 and 389.)

IX. ROLE OF THE SMALL INTESTINE IN FAT ABSORPTION (236-287)

- A. Histological Changes**
- B. Hydrolysis**
- C. Desaturation**
- D. Esterification with Cholesterol**
- E. Phosphorylation**
- F. Emulsification**

A. Histological Changes

236. ON CELLULAR CHANGES IN INTESTINAL FAT ABSORPTION

W. Cramer and R. J. Ludford. *J. Physiol.* 60, 342 (1925)

Experiments on rats and mice. In the synthesis of fat, which proceeds in the cells of the intestinal epithelium during fat absorption, the Golgi apparatus is the cell structure mainly concerned.

In the absence of vitamins A and B the appearance suggests that unsplit fat is being absorbed. When non-fatty foods are absorbed, no change in the Golgi apparatus is noted.

The mitochondria do not appear to take any active part in fat absorption.

237. ON FAT ABSORPTION AND THE HISTOLOGY OF THE SMALL INTESTINE

M. Danby. *Z. f. Mikro. Anat. Forschung* 36, 23 (1933)

A histological study of the distribution of fat in the small intestine of guinea pigs during fat absorption was made.

238. CONCLUSIONS TO THE HISTOPHYSIOLOGY OF THE INTESTINE

P. B. Weel. *Z. f. Zell. u. Mikro. Anat.* 29, 750 (1939)

A histological study of fat absorption is described.

239. STUDIES ON DIRECT AND VISIBLE INGESTION OF FAT BY DIFFERENTIATED BODY CELLS OF THE CAT

R. M. Wotton and R. L. Zwemer. *Anat. Rec.* 75, 493 (1939)

This histological study shows that fat droplets pass through the cuticular border of intestinal columnar cells leaving at the basement membrane into the marginal capillary. The drops in the blood capillaries are carried directly to the liver by the portal system. The histological picture was no different for fats of high or low melting point or for animal or vegetable fats. Mineral oil did not pass through the columnar cells.

240. THE FREE BORDER OF THE INTESTINAL CELLS OF VERTEBRATES

John R. Baker. *Quart. J. Micro. Sci.* 84, 73 (1942)

The free border consists essentially of three layers:

- a. A superficial layer, pierced by pores, next the lumen of the intestine.
- b. A canal layer, pierced by spindle-shaped canals continuous with the pores of the superficial layer. These canals traverse the layer at right angles to its surface.
- c. A granular layer, containing many spherical granules, next the cytoplasm of the cell.

It is suggested that unhydrolysed fats may enter the intestinal epithelial cell through the pores and canals in the form of extremely fine droplets.

(See also Nos. 103, 173, 199, 203, 241, 247, 278, 411 and 587.)

B. Hydrolysis

241. ON THE MODE OF ABSORPTION OF FATS

B. Moore and D. P. Rockwood. *J. Physiol.* 21, 58 (1897)

It is concluded that fats are absorbed either as fatty acids or as soaps in dogs. That fats are not absorbed in the emulsified form is shown:

- 1) Fat droplets were not observed in the striated border of epithelial cells.
- 2) The milky lacteals were only observed in the region of the small intestine that contained clear fluid.
- 3) Emulsification of fats in the small intestine did not always take place.

242. ON THE DETRIMENTS OF HEALTH CAUSED BY THE USE OF HORSE MEAT

E. Pfluger. *Arch. Physiol. Pflug.* 80, 111 (1900)

The absorption of fat is discussed. It is claimed that the absorption takes place only in the form of hydrolysed fats.

243. ON CALCIUM SOAPS AS PROOF AGAINST THE ABSORPTION OF FAT IN AQUEOUS SOLUTION

E. Pfluger. *Arch. Physiol. Pflug.* 89, 211 (1902)

The work of Otto Lowi is discussed and criticized.

244. ON THE DIGESTION OF FATS IN THE ANIMAL ORGANISM

S. Levites. *Z. physiol. Chem.* 49, 273 (1906)

In dogs the fats are hydrolysed in the intestine. In the stomach only very little splitting takes place and no absorption occurs. The amount of fat splitting and the amount of fat absorbed are found to be correlated.

245. THE QUESTION OF ESTER ABSORPTION

R. Schonheimer and R. Hummel. *Z. physiol. Chem.* 192, 114 (1930). *C. A.* 325 (1931)

Whereas cholesteryl palmitate, stearate, and oleate are stored in the liver of mice after feeding, cholesteryl oxalate undergoes saponification and only the cholesterol is deposited.

246. PROBLEMS AND RESULTS IN THE FIELD OF INTESTINAL ABSORPTION

F. Verzar. *Ergebnisse d. Physiol.* 32, 445 (1931)

The work of Mellanby on the absorption of finely emulsified fat as such is criticized on the basis that lipases were found in the isolated cat intestine. It is shown that both bile acids and lipases are necessary for fat absorption. An extensive review of the literature on absorption is presented.

247. CONTRIBUTIONS TO THE PHYSIOLOGY OF FAT ABSORPTION

G. Farkas and L. Thanhoffer. *Z. Biol.* 93, 560 (1933)

By histological methods it was shown that olive oil and milk fat are not absorbed from a portion of the intestine of a frog free of lipases, but that soaps are absorbed. The latter are also absorbed in the absence of bile but to a lesser degree.

248. EXPERIMENTAL HISTOCHEMICAL INVESTIGATIONS OF LECITHIN METABOLISM IN THE ANIMAL BODY. I. THE RESORPTION OF LECITHIN IN THE INTESTINE

J. Ackermann. Bull. intern. polon. sci. Classe sci. math. nat. 2, 177 (1936B).
C. A. 1475 (1937)

Lecithin was fed to frogs.

The intestinal wall was investigated chemically and histologically.

Neutral fat increased, phospholipid did not. Apparently phospholipid is hydrolysed in the intestine.

249. LIVER RHYTHM AND FAT ABSORPTION

H. Holmgren. Deut. Med. Wochschr. 64, 744 (1938)

It is shown that in the rat independent of the time of feeding a rhythmical splitting, absorption, and storage of food occurs.:

Liver fat, intestinal fat, and pancreatic activity were measured in groups of rats.

(See also Nos. 77, 81, 108, 111, 115, 133, 149, 162, 280, 289, 290, 316, 317, 345, 427, and 577.)

C. Desaturation

250. ON FAT ABSORPTION

W. R. Bloor. J. Biol. Chem. 16, 517 (1913)

Thoracic duct of dogs was cannulated; the dogs then recovered from the anesthesia.

The intestine appears to have the power to modify radically the composition of fats during fat absorption (elevation or lowering of melting point, lowering of iodine number). The changes are such as to produce a uniform chyle fat, presumably the characteristic body fat of the animal.

Note: The influence of the liver on the absorbed fats does not seem to be excluded by this method.

251. THE FAT ABSORPTION BY DESATURATION OF FATTY ACIDS

H. Tangl and N. Berend. Biochem. Z. 220, 234 (1930)

Some fatty acids were dialyzed at body temperature with the addition of pancreatic juice and bile.

From the results it is concluded that in vitro and fatty acids are desaturated in the intestine, which makes them water soluble; they are then absorbed as water soluble fatty acids.

252. THE PRESENCE IN BILE OF A DEHYDROGENASE ACTIVE ON STEARIC ACID

G. Quagliariello. Atti. Acad. Lincei. 16, 378 (1932). C. A. 2461 (1933)

253. ON SURFACE ACTIVITY AND SOLUBILITY OF THE PHYSIOLOGICALLY MOST IMPORTANT FATTY ACIDS

F. Eredi. Biochem. Z. 273, 273 (1934)

Stearic acid and oleic acid only give a stable solution at body temperature in an alkaline medium.

Linoleic acid is soluble near neutrality, and linoleic and arachidonic acid are soluble in weakly acid medium.

The presence of very unsaturated acids also increases the solubility of the less unsaturated acids.

254. THE DESATURATION OF FATTY ACIDS IN THE ORGANISM

R. Schoenheimer and D. Rittenberg. J. Biol. Chem. 113, 505 (1936)

Mice were fed saturated fatty acids containing deuterium; the fatty acids of the entire animals were freed of the last traces of deuterium-containing saturated fatty acids by a method developed for this special purpose. The high deuterium content of the unsaturated fatty acids so secured proves conclusively that fatty acids can readily be desaturated in the organism.

255. FAT METABOLISM IN FISHES

J. A. Lovern. *Biochem. J.* 34, 704 (1940)

Ethyl myristate, ethyl palmitate and ethyl esters of mixed unsaturated acids were fed to eels and were well absorbed.

The results afford some support for the theory of inter-convertibility of certain saturated and unsaturated fatty acids by fish.

(See also Nos. 345, 350, 405, 554, 579, and 580.)

D. Esterification with Cholesterol

256 ON THE CHOLESTEROLESTEARASES AND THEIR RELATION TO FAT ABSORPTION

G. Schramm and A. Wolff. *Z. physiol. Chem.* 263, 61 (1940)

It is proposed that the formation of cholesterol esters during fat absorption is important in fat absorption. This also explains why bile is necessary.

257. CHOLESTEROL AND FAT ABSORPTION

P. Favarger. *Arch. Int. Pharm.* 68, 409 (1942). C. A. 5911 (1944)

Esterification of cholesterol with elaidic acid occurs in the intestine. This supports the view that fatty acids are absorbed partly as their cholesterol ester.

(See also Nos. 133, 140, 145, and 259.)

E. Phosphorylation

258. SYNTHESIS OF LECITHIN IN THE ANIMAL ORGANISM

Henry C. Eckstein. J. Biol. Chem. 62, 743 (1925)

Anesthetized dogs are used.

The phospholipid content of lymph was found independent of fat absorption. Palmitic acid did not increase lymph phosphatide, but oleic acid did (toxicity?). Ingestion of lecithin increased the total fatty acids of lymph markedly but only slightly augmented the phosphatide content of lymph.

It is thought unlikely that phosphatide synthesis occurs before the fat enters the blood stream.

259. LIPID METABOLISM IN STARVING DOGS

H. Wendt. Klin. Wochschr. 7, 2183 (1928)

In the starving dog the phospholipid and cholesterol of plasma increase in the first few days and then fall below normal.

The increase in phospholipid and cholesterol of plasma after feeding triolein is more marked in the starved than in the normal dog. It is thought that these facts provide evidence that phospholipids and cholesterol esters are intermediates.

260. THE ROLE OF PHOSPHOLIPIDS OF THE INTESTINAL MUCOSA IN FAT ABSORPTION

Robert Gordon Sinclair. J. Biol. Chem. 82, 117 (1929)

Cats are used and iodine number is taken as the index of composition of phospholipid. Absorption of fat changes the composition of phospholipid in the small intestine but not the amount. Phospholipid formation is held to be an essential step in the resynthesis of neutral fat.

261. RETARDATION OF FAT ABSORPTION BY MONOiodoacetic acid AND PHLORIZIN

F. Verzar and L. Laszt. Biochem. Z. 270, 35 (1934)

In rats, the absorption of orally administered fats is slowed down when they are poisoned by subcutaneous injections of phlorizin and monoiodoacetic acid.

It is concluded that phosphorylation in the intestine plays a part in fat absorption.

262. PHOSPHATE SYNTHESIS IN THE INTESTINE DURING FAT ABSORPTION

H. Sullmann and W. Wilbrandt. Biochem Z. 270, 52 (1934)

Fasted rabbits were used. Fat emulsions in water plus NaOH were fed by stomach tube. They found it necessary to take intestinal lymph and not thoracic duct lymph, the latter causing erratic results.

The circulating rate through the portal system is calculated to be too large to detect a measurable increase in phospholipid level in it after fat absorption.

Phosphatide and total fat level of intestinal lymph rise after fat absorption in about the same proportion, but only 1/5 - 1/3 of the total fat is in the form of phosphatide fatty acids.

263. THE LIPIDS OF THE INTESTINAL MUCOSA DURING THE ABSORPTION OF IODATED FATS

C. Arton and G. Peretti. *Arch. Internat. Physiol.* 42, 61 (1935)

Rabbits were used. It is pointed out that de-iodination of the fatty acids may occur in metabolic processes.

The evidence seems most suggestive of phosphorylated lipids playing a part in fat absorption.

The presence of large amounts of acetone soluble P in the small intestine is said to be suggestive of active metabolism and formation of breakdown products of phospholipids.

264. THE SYNTHESIS OF NEUTRAL FAT BY THE INTESTINE OF DIABETIC DOGS

S. Freeman and A. C. Ivy. *Am. J. Physiol.* 114, 132 (1935)

As in normal dogs, oleic acid is absorbed from the intestine of depancreatized diabetic dogs, largely as neutral fat and phospholipid. Thus, glycerol is freely available for neutral fat synthesis in the absence of insulin. Neither is phosphorylation of the absorbed fatty acid, as indicated by the rise in lipid phosphorus in the chyle, impaired.

During the absorption of fatty acid, the free and total cholesterol content of the chyle of normal dogs shows an increase which parallels that of the other fatty fractions. This increase is largely absent in the diabetic (depancreatized) dog.

The experiments were carried out under nembutal.

265. THE ACTIVITY OF THE INTESTINAL MUCOSA IN ABSORPTION

F. Verzar. *Schweiz. Mediz. Wochschr.* 25, 569 (1935)

The experiments of Verzar, Laszt, and Sullman are discussed. It is concluded from the inhibition of fat absorption by monoiodoacetic acid and phlorizin that phosphorylation takes place in absorption.

Also data on intestinal lymph are discussed.

266. INHIBITION OF FAT ABSORPTION

F. Verzar. *J. Physiol.* 84, 41P (1935)

It is concluded that fat absorption probably is dependent on an active process in the intestinal mucosa which synthesizes the fatty acids to phospholipids and neutral fats under the influence of the adrenal cortex.

267. THE ROLE OF THE PHOSPHOAMINO LIPIDS OF THE INTESTINAL MUCOSA IN THE ABSORPTION OF FATS. I. QUALITATIVE VARIATIONS AFTER THE ADMINISTRATION OF IODIZED FATS.

C. Artom and G. Peretti. *Boll. Soc. Ital. Biol. Sper.* 10, 867 (1936). C. A. 2624 (1936)

Rabbits were used.

Most iodine is found in the acetone soluble fraction; 2.5-7.4% of that amount in the

acetone insoluble fraction.

268. THE ROLE OF THE PHOSPHOAMINO LIPIDS OF THE INTERIC MUCOSA IN THE ABSORPTION OF FATS. II. QUANTITATIVE VARIATIONS AFTER THE ADMINISTRATION OF FATS

C. Artom and G. Peretti. *Boll. Soc. Ital. Biol. Sper.* 10, 869 (1936). C. A. 2624 (1936)

Total lipid P, P and fat acids in acetone precipitate, Acetone soluble P, Phosphoamino lipid P, and Carnitine P are measured at different intervals.

269. SYNTHESIS OF PHOSPHOLIPIDS DURING ABSORPTION OF FAT

C. Artom, C. Perrier, M. Santangelo, G. Sarzana and E. Segre. *Boll. Soc. Ital. Biol. Sper.* 12, 275 (1937). C. A. 7897 (1937)

270. SYNTHESIS OF PHOSPHOLIPIDS DURING THE ABSORPTION OF FATS

C. Artom, G. Sarzana, C. Perrier, M. Santangelo and E. Segre. *Arch. Internat. Physiol.* 45, 32 (1937)

Rats are used in the experiments. Oil and P^{32} are simultaneously administered by stomach tube. In liver, intestine and kidney predominantly radioactive phospholipids are found. It is suggested that the analogy with the occurrence of beta and omega oxidation of fatty acids in those tissues may be significant with respect to the role of phospholipids in fat metabolism.

271. PHOSPHOLIPID SYNTHESIS DURING FAT ABSORPTION

C. Perrier, C. Artom, M. Santangelo, G. Sarzana and E. Segre. *Nature* 139, 1105 (1937). C. A. 6314 (1937)

Olive oil and P^{32} were fed to a rat. Most of the radioactive phospholipid was subsequently found in the liver and gut.

272. THE TURNOVER OF PHOSPHOLIPIDS IN THE INTESTINAL MUCOSA

Robert Gordon Sinclair and Clair Smith. *J. Biol. Chem.* 121, 361 (1937)

Cats were used. Saturated as well as unsaturated fatty acids replace each other in the intestinal phospholipids according to which fat is fed. Fifty per cent the normal fatty acids can be replaced by elaidic acid.

Large amounts of oleic and linoleic acids (olive and corn oil) do not appreciably decrease the per cent of solid acids in the mucosal phospholipids. Each tissue phospholipid seems to have a constant ratio of saturated and unsaturated acids. Elaidic acid may take the place of saturated as well as unsaturated acids.

273. INFLUENCE OF DIETARY FAT ON THE FORMATION OF PHOSPHOLIPIDS IN ANIMAL TISSUES

C. Artom, G. Sarzana and E. Segre. *Arch. Internat. Physiol.* 47, 245 (1938)

P^{32} is used as indicator. Five rats are used. Rates of formation of phospholipids in different tissues are calculated from specific activities. The hypothesis is made

that during fat absorption the formation of "metabolic" phospholipids is superimposed upon the formation of "Structural" phospholipids. It is also thought that the metabolic phospholipids are an end product (carried into the blood) and not intermediaries in the formation of neutral fat.

274. THE INTESTINAL PHOSPHATASE DURING THE ABSORPTION OF NEUTRAL FAT IN NORMAL AND RICKETY RATS

L. Bellini and B. Cera. *Pathologica* 32, 195 (1940)

During the absorption of neutral fats, the phosphatase activity of the small intestine of albino rats increases; in the experimentally rickety rats, this activity is higher than in normal rats.

275. PHOSPHORUS CHANGES DURING THE ABSORPTION OF OIL AND GLUCOSE

R. Reiser. *J. Biol. Chem.* 135, 303 (1940)

There is a decrease in serum and urinary inorganic phosphate after the ingestion of olive oil by human subjects.

During the absorption of cottonseed oil by swine there is (a) an increase in both phosphate fractions of the duodenal mucosa, (b) no change in the inorganic but an increase in the ester phosphate of the liver, and (c) no change in inorganic but an increase in ester phosphate of the kidney.

276. THE ABSORPTION OF NEUTRAL FATS ASSOCIATED WITH NA-GLYCEROPHOSPHATE AND THE BEHAVIOR OF THE INTESTINAL PHOSPHATASE

B. Cera and L. Bellini. *Pathologica* 32, 375 (1940). C. A. 1474 (1941)

The absorption of olive oil by rats is greatly increased by the addition of Na-glycerophosphate to the oil. The experiments show that intestinal phosphatase participates directly in the absorption of fat.

277. THE ABSORPTION AND TRANSPORT OF FATTY ACIDS ACROSS THE INTESTINAL MUCOSA

Richard H. Barnes, Elmer S. Miller and George O. Burr. *J. Biol. Chem.* 140, 233 (1941)

Rats were fed methyl esters of conjugated fatty acids of corn oil. The rate of absorption is found to decrease with time, but corn oil itself is absorbed at a constant rate. The tagged fatty acids are incorporated very rapidly into the neutral fat of the small intestine mucosa, but after two hours their per cent in that fraction drops. They accumulate slowly in the phospholipids of the small intestine. The total neutral fat also shows an increase and then a decrease. The fat absorbed in different intervals over a 14-hour period is calculated. If their data can be trusted they show that phosphorylation is of little importance in fat absorption.

278. THE LIPIDS OF THE DUODENAL MUCOSA OF SWINE DURING THE ABSORPTION OF FAT

R. Reiser. *J. Biol. Chem.* 143, 109 (1942)

There is no change in the phospholipid or cholesterol content of the duodenal mucosa of swine during absorption.

There are no triglycerides in the fasting duodenal mucosa of swine and only small amounts, if any, during absorption.

About 2.5 per cent of the dried weight of fasting mucosa is free fatty acid, and this amount is approximately doubled 5 hours after the ingestion of oil.

The apparently great increase in fat observed histologically does not represent any increase in the fat content of the mucosa cells but an increase in the amount of stainable fat.

279. ABSORPTION OF FAT ACIDS BY THE INTESTINAL MUCOSA

G. E. Cardini and M. E. Serante's. *Rev. Soc. Argentina Biol.* 20, 132 (1944). C. A. 1914 (1945)

Rats were fed ration with 22% olive oil. Fatty acids in mucosa doubled, phospholipid changed little. The unsaturated fatty acids seemed to be absorbed more readily into the mucosa but appeared later in the blood.

(See also Nos. 197, 200, 205, 285, 416, 419, 420, 424, 457, 458, 462, 530 and 595.)

F. Emulsification

280. EXPERIMENTS ON THE ABSORPTION OF FATS FROM THE SMALL INTESTINE

W. Croner. *Biochem. Z.* 23, 97 (1910)

It is found on dogs that only the lower part of the small intestine absorbs soaps.

Emulsified fats were found to be absorbed from all parts of the intestine. Fats are therefore not usually absorbed as soaps.

281. THE PROBLEM OF FAT ABSORPTION

A. Kuthy. *Klin. Wochschr.* 14, 308 (1935)

A theory of emulsification of fats is discussed.

282. EVIDENCE OF FAT/FATTY ACID PARTITION IN HUMAN FAT ABSORPTION

A. C. Frazer and H. C. Stewart. *J. Physiol.* 94, 24P (1939)

If olive oil is taken by duodenal tube, a marked increase in chylomicrons very soon occurs. If an equivalent amount of oleic acid and glycerol is taken, no rise is found in the particle curve. Lipase also causes a very marked decrease in systemic lipemia.

Chylomicron technique was used.

283. THE MECHANISM OF EMULSIFICATION OF TRIGLYCERIDE IN THE SMALL INTESTINE

J. J. Elkes, A. C. Frazer, J. H. Schulman and H. C. Stewart. *J. Physiol.* 108, 6P (1944)

Satisfactory emulsifying agents in the intestine should: 1) be effective over a pH range of 6.0-8.5; 2) give spontaneous emulsification without violent agitation; 3) produce a particle size of less than 0.5 diameter; 4) be stable for a period of 3 hours.

The only satisfactory combination found was monoglyceride/fatty acid/bile salt.

284. THE RELATIONSHIP OF PHOSPHOLIPID TO THE ABSORPTION OF UNHYDROLYSED FAT FROM THE INTESTINE

J. J. Elkes and A. C. Frazer. *J. Physiol.* 102, 24P (1944)

It is suggested that the interfacial film of the emulsion in the lumen of the intestine contains no phospholipid whereas the chylomicrons do.

Evidence is presented on the basis of positive or negative flocculation tests with lecithinase.

285. LIPOLYSIS AND FAT ABSORPTION

A. C. Frazer. *J. Physiol.* 102, 329 (1944)

Rats fed with neutral fat with added lipase show sequelae normally associated with the ingestion of fatty acid, such as fine granular deposition in the intestinal cells, portal rather than systemic lipemia, and deposition in the liver instead of in the fat depots.

In the human subjects under standard conditions, the systemic postabsorptive lipemia can be almost entirely prevented by the simple addition of lipase to the fat-

containing food.

The complete inhibition of lipolysis by sodium cetyl sulphate in rats does not prevent triglyceride absorption in amounts comparable with, or rather greater than, those absorbed by the control groups in the same time.

It is suggested that lipolysis is not an essential step in fat absorption but that it determines the fate of absorbed fat and provides fatty acid for the formation of soap and phospholipids.

286. EMULSIFICATION OF FAT IN THE INTESTINE OF THE RAT AND ITS RELATIONSHIP TO ABSORPTION

A. C. Frazer, J. H. Schulman and H. C. Stewart. *J. Physiol.* 103, 306 (1944)

Olive oil is emulsified in rat intestine; paraffin is not.

Fine paraffin emulsions (stabilized) are absorbed as much as the olive oil emulsion. The triple combination bile salt/fatty acid/monoglyceride is shown to be the most effective emulsifying agent over a range of pH 6-8.5. It is felt that the partial lipolysis in the intestine produces this system, which makes it possible that fat globules are absorbed as such.

287. THE RELATIONSHIP OF LIPOLYSIS TO EMULSIFICATION OF TRIGLYCERIDE IN THE SMALL INTESTINE

A. C. Frazer, H. G. Sammons. *J. Physiol.* 103, 5P (1944)

Spontaneous emulsification of olive oil occurs only when fatty acids, bile salts and many glycerides are present.

In vivo the emulsified particle is negatively charged and resistant to acid at pH 4.0.

(See also Nos. 240, 288, 289, 290, 345 and 556.)

X. ROLE OF THE LARGE INGESTINE IN FAT ABSORPTION (288-290)

288. ON THE QUESTION OF ABSORPTION OF EMULSIFIED FATS FROM THE LARGE INTESTINE

S. Yamakawa and T. Nomura. *Tohoku J. Exp. Med.* 14, 265 (1929)

From chemical studies of rectal feeding it is found that 80-100% of the emulsified fat is absorbed in 24 hours. In one dog it was found that lymph and blood fat are increased and it is said that the main part of the fat is absorbed by way of the lymph.

289. FAT ABSORPTION FROM THE LARGE INTESTINE

R. Kitagawa. *Tohoku J. Exp. Med.* 24, 329 (1934)

Emulsified fats are absorbed from the large intestine and the lower part of the small intestine of dogs without any apparent lipolysis taking place.

290. HISTOLOGICAL EXAMINATIONS CONCERNING THE FAT ABSORPTION FROM THE LARGE INTESTINE

T. Onozaki. *Tohoku J. Exp. Med.* 29, 224 (1936)

It is shown that finely emulsified fat is absorbed from the large intestine without first being hydrolyzed.

(See also No. 316.)

XI. FUNCTION OF THE LIVER IN FAT ABSORPTION (291-306)

291. EXPERIMENTAL INVESTIGATIONS ON THE ROLE OF THE LIVER IN FAT ABSORPTION UNDER NORMAL AND PATHOLOGICAL CONDITIONS

G. Joannovics and E. P. Pick. *Wien. Klin. Wochschr.* 23, 573 (1910)

See same authors *Deut. Path. Ges.* 14, 268 (1910).

292. EXPERIMENTAL INVESTIGATIONS ON THE SIGNIFICANCE OF THE LIVER IN FAT ABSORPTION IN NORMAL AND PATHOLOGICAL CONDITIONS

G. Joannovics and E. P. Pick. *Deut. Path. Ges.* 14, 268 (1910)

Experiments on dogs with Eck fistula were performed. Absorbed fat reaches the liver by way of the portal vein. Phosphorus poisoning is studied.

293. THE LIPIDS OF THE LIVER DURING THE ABSORPTION OF FAT

M. C. Artom. *Societe Chimie Biol.* 13, 975 (1931)

Horse fat was fed to dogs. It was found that liver phospholipids are increased 30% within 5-8 hours after fat feeding. Total fatty acids increase irregularly and often very little.

294. THE LIVER LIPOIDS DURING ABSORPTION OF NEUTRAL FAT

C. Artom. *Arch. di Fisiol.* 32, 57 (1933). C. A. 2484 (1933)

Neutral fat was fed to dogs. It was shown that liver phospholipids increase for 6 hours, then suddenly return to normal.

296. THE FATE IN THE ORGANISM OF RESORBED FAT

H. Schur, A. Low and A. Krema. *Wien. Arch. Inn. Med.* 25, 197 (1934). C. A. 7333 (1934)

In fasting mice a single administration of oil and fat will lead to such an increase of fat in all the fat depots, that these animals are suitable subjects for the determination of the action of fat metabolism of various substances, particularly insulin. The increase in lipid content of the whole animal, of the liver and of the mesentery after such feeding of fat parallels the increase in fat content. The carbohydrate content of the liver often decreases after feeding of fat, while the carbohydrate content of the mesentery increases.

297. THE LIVER AND FAT METABOLISM

Francis Xavier Aylward, Harold John Channon and Harry Wilkinson. *Biochem. J.* 29, 169 (1935)

Rats were fed complete high-fat meals containing cholesterol, with and without choline. The phosphatide level in the liver decreased after feeding, but choline prevented the drop to a great extent. The neutral fat rose, but the rise was somewhat inhibited by choline. Free cholesterol did not change; cholesterol esters increased. Different groups sacrificed at different time intervals did not absorb equal amounts of fat per time unit. The amounts of choline absorbed were not measured.

298. FAT ABSORPTION--ITS VALUE AS AN INDEX OF FUNCTION OF THE LIVER

Maurice Sullivan and John A. B. Fehrstand. Arch. Int. Med. 55, 834 (1935)

Fat absorption curves after ingestion of 100 gm. of cottonseed oil are determined by the serum lipid values. Normal individuals show maximum level 6 hours after the ingestion and normal again 9 hours after. In diabetic patients the pattern is the same, only the lipid level at 9 hours is still rather high. In patients with diseased liver the curves show diminished and delayed absorption.

299. THE APPLICATION OF ISOTOPIC INDICATORS IN BIOLOGICAL RESEARCH

G. Hevesy. Enzymologia 5, 138 (1938)

Plasma lecithin is found to increase in a dog after administration of olive oil. It is claimed that labeling with P^{32} showed that the additional lecithin did not come from the intestine.

It has also been found that more labeled phospholipid is formed in the isolated liver perfused with lipemic blood than in one perfused with normal blood.

300. LOWERED SERUM LIPID LEVELS IN THE ECK FISTULA DOG

I. C. Winter, J. E. von Dolah and L. A. Crandall. Am. J. Physiol. 133, 566 (1941)

The Eck fistula dog does not manifest the normal lipemic curve even when given twice the amount of fat that effectively increases the serum fatty acids in normal dogs. This is not due to a failure in absorption as determined by fecal fat loss.

301. ON DISTURBANCES OF FAT AND CHOLESTEROL ABSORPTION AND THE FATE OF CHOLESTEROL IN THE INTESTINE OF PATIENTS WITH CIRRHOSIS OF THE LIVER

M. Burger and W. Winterseel. Z. Exp. Med. 66, 463 (1929)

302. ON THE INTERFERENCE OF FAT ABSORPTION IN CIRRHOSIS OF THE LIVER AND OTHER DISEASES

H. Wendt. Klin. Wochschr. 8, 1566 (1929)

In humans no alimentary lipemia occurred after fat feeding. Often low cholesterol levels were found. It is concluded that cirrhosis interferes with fat absorption because of an accumulation of blood in the portal vein area.

303. ALIMENTARY CHOLESTEREMIA IN LIVER DISEASES

S. Leites and A. Golbitz-Katschan. Z. Exp. Med. 72, 690 (1930)

People with liver disease may not show a cholesteremia; the latter may even decrease after a meal of olive oil and cholesterol.

304. FAT METABOLISM IN THE DOG FOLLOWING LIVER INJURY PRODUCED BY CARBON TETRACHLORIDE

I. C. Winter. J. Biol. Chem. 124, 339 (1938)

In dogs after treatment for a week with carbon tetrachloride the response to linseed oil feeding is normal in plasma in amount and iodine number change. After 3 months' treatment, although the response is normal in amount, no change in iodine number occurs.

305. LIPEMIA IN EXPERIMENTAL CARBON DISULFIDE POISONING

E. Bianchi. Med. d. Lavarò 29, 213 (1938)

306. ALIMENTARY LIPEMIA IN LIVER DISEASES

P. Mauriac, L. Servantie, P. Laval and A. Baron. Compt. rend. soc. biol. 136, 559 (1942)

It is concluded that the extent of alimentary lipemia after a fatty meal is an index of liver disorder.

(See also Nos. 436, 454, 496 and 546.)

XII. FUNCTION OF THE PANCREAS IN FAT ABSORPTION (307-363)

A. In Vivo

B. In Vitro

A. In Vivo

307. THE ABSORPTION FROM THE INTESTINE AFTER LIGATION OF THE PANCREATIC DUCT

A. Niemann. *Z. Exp. Path.* 5, 466 (1909)

It is concluded that in the dog no retardation of fat absorption occurs when pancreatic juice is excluded from the intestine.

308. THE DIGESTION AND ABSORPTION WHEN THE PANCREAS IS ELIMINATED

O. S. Holmberg. *Z. physiol. Chem.* 74, 354 (1911)

When in dogs both pancreatic ducts are ligated and cut, fat absorption is only temporarily and slightly interfered with. It is believed that this, however, does not represent the complete exclusion of all the external secretion from the gut. When the pancreas is removed completely, greater disturbances in absorption occur.

309. EXPERIMENTS ON PATIENTS WITH DISEASES OF THE PANCREAS

O. Gross. *Deut. Arch. Klin. Med.* 108, 106 (1912)

Fat and nitrogen absorption is studied. It is noted that in many cases splitting of the fat has occurred but that no absorption has taken place. The influence of feeding pancreatic preparations is studied.

310. THE DIGESTION AND ABSORPTION OF PROTEIN AND FAT IN NORMAL AND DEPANCREATIZED ANIMALS

E. W. H. Cruickshank. *Biochem. J.* 9, 138 (1915)

<u>Dog preparation</u>	<u>% Fat utilized</u>
Normal dog, high fat diet	97-99
Normal dog, low fat diet	87
Depancreatized dog with part of gland grafted in abdominal wall	85
Depancreatized dog with part of gland in situ	82
Depancreatized dog (without pancreas)	72

311. EFFECT OF EXCLUDING PANCREATIC JUICE FROM THE INTESTINE ON THE ABSORPTION OF NITROGEN AND FAT

J. H. Pratt. *Am. J. Physiol.* 40, 145 (1916)

Six pancreatic duct ligated dogs were used. Disturbances in fat and nitrogen absorption occurred. The fat in the feces was well split. Feeding of fresh pancreas improved absorption.

312. THE ABSORPTION OF FAT IN PARTIALLY, AND IN COMPLETELY DEPANCREATIZED DOGS

C. W. McClure, B. Vincent and J. H. Pratt. *J. Exp. Med.* 25, 381 (1917)

A historical development of the investigation of the influence of the pancreas on fat absorption is given. It was found that dogs with a subcutaneous transplant secreting and discharging pancreatic juice externally absorbed no more fat than dogs in which

the pancreatic remnant was undergoing rapid atrophy and sclerosis. Hence the condition of the pancreatic tissue remaining in the body does not influence the amount of fat absorbed by the intestine.

The absorption of fat by the intestinal mucous membrane is always markedly disturbed when the pancreatic secretion is excluded from the intestine.

After the complete removal of all pancreatic tissue from an animal, the absorption of considerable amounts of fat can still take place.

313. PANCREAS FUNCTION AND PANCREAS DIAGNOSIS

T. Brugsch. *Z. Exp. Path.* 20, 473 (1919)

The incomplete absorption of fats in patients with a diseased pancreas and in pancreatic duct ligated dogs is discussed from the clinical point of view.

314. THE ABSORPTION OF FAT IN PIGEONS AFTER LIGATING THE PANCREATIC DUCTS

G. Sarzana. *Boll. Soc. Ital. Biol. Sper.* 6, 322 (1931). *C. A.* 5460 (1931)

Before ligating the ducts, the average per cent of absorption of fats was: oleic acid 95, olive oil 94, butter 92; after ligating the ducts: oleic acid 78, olive oil 50, butter 37, oleic acid plus pancreatic juice 88, olive oil plus pancreatic juice 84.

315. SUBSTITUTION OF "LECITHIN" FOR RAW PANCREAS IN THE DIET OF THE DEPANCREATIZED DOG

J. H. Hershey and S. Soskin. *Am. J. Physiol.* 98, 74 (1931)

When 10 gm. of fat was added to the diet of three dogs, they absorbed 50, 30, 80%, respectively. In all cases the urine became darker in color and gave a positive reaction for bile.

316. DOES THE PANCREAS INFLUENCE FAT ABSORPTION EXCEPT BY ITS LIPOLYTIC ACTION?

M. Nothmann, H. Wendt. *Arch. Exp. Path. u. Pharm.* 162, 472 (1931)

Depancreatized dogs were fed olive oil, which was found to be absorbed very poorly. It is shown that the fat in the small intestine is not split more than 4%, but that a greater amount of splitting occurs in the large intestine. For this reason one should be careful in drawing conclusions from the amounts of free fatty acids found in fecal fat of depancreatized dogs.

317. DOES THE PANCREAS INFLUENCE FAT ABSORPTION?

M. Nothmann and H. Wendt. *Arch. Exp. Path. u. Pharm.* 164, 266 (1932)

Oleic acid was fed to depancreatized dogs, and it was found to be well absorbed in contrast to the absorption of neutral fat, which is greatly disturbed in these dogs.

This is taken to mean that the only influence of the pancreas on fat absorption is its lipolytic activity. Any possible influence of the pancreas on absorption of unsplit neutral fat is not discussed.

318. NEWER INVESTIGATIONS ON THE FUNCTION OF THE PANCREAS IN FAT ABSORPTION

M. Nothmann and H. Wendt. *Klin. Wochschr.* 11, 2137 (1932)

A discussion of the role of the pancreas in fat absorption is given to show that only the external secretion plays a specific part in fat absorption. It is said, however, that in the depancreatized dog the stomach emptying time is decreased markedly, and this may indirectly influence absorption.

319. AN ATTEMPT TO REPRODUCE COELIAC DISEASE EXPERIMENTALLY IN YOUNG ANIMALS BY EXCLUDING THE EXTERNAL PANCREATIC SECRETION FROM THE INTESTINE

J. Greenberg. *Yale J. Biol. and Med.* 6, 121 (1933)

Complete exclusion of the pancreatic juice of the cat resulted in an almost complete failure of fat absorption.

An extensive bibliography is presented.

320. THE ABSORPTION OF FATS IN PANCREATIC INSUFFICIENCY (HUMANS)

N. Poczka and W. Fischel. *Deut. Arch. Klin. Med.* 177, 14 (1934)

Lard and olive oil are not absorbed at all; butter was very well tolerated. Blood fat and blood cholesterol do not rise after feeding with cholesterol dissolved in oil.

321. THE EFFECT OF VARIATIONS IN THE DIET ON THE ABSORPTION OF FOOD IN THE ABSENCE OF PANCREATIC DIGESTION

M. B. Handelsman, L. A. Golden and J. H. Pratt. *J. Nutr.* 8, 479 (1934)

Dogs with pancreatic juice wholly excluded from the intestine can be made to absorb large quantities of food, including fats, even though a high percentage of the nitrogen and fat of the diet may appear in the stools. The carbohydrates fed are usually well absorbed in the absence of pancreatic digestion.

322. CONTRIBUTION TO PANCREATOGENIC LIPEMIA

W. Brünner. *Klin. Wochschr.* 14, 1853 (1935)

In patients with pancreatitis fat metabolism was studied and deviations from the normal person were found to exist.

323. THE EFFECT OF ENTERIC COATED PANCREATIN ON FAT AND PROTEIN DIGESTION OF DEPANCREATIZED DOGS

Wilbur Arthur Selle. *J. Nutr.* 13, 15 (1937)

The dogs were sustained with insulin, and addition of pancreatin to the meat diet failed to check the loss of fat in feces. Larger amounts of pancreatin were possibly less effective than the smaller amounts in the digestion of fat.

324. ABSORPTION OF OLEIC ACID FROM VELLA FISTULA IN A DEPANCREATIZED DOG
U. Lombroso, L. Bellini and S. Filippin. *Boll. Soc. Ital. Biol. Sper.* 12, 580 (1937).
C. A. 633 (1938)
325. ABSORPTION OF NEUTRAL FATS FROM VELLA FISTULA IN DEPANCREATIZED DOGS
U. Lombroso, L. Bellini and S. Filippin. *Boll. Soc. Ital. Biol. Sper.* 12, 579 (1937).
C. A. 633 (1938).
326. AN EXPERIMENTAL STUDY OF OPERATIONS WHICH INVOLVE EXCLUSION OF THE PANCREATIC SECRETION FROM THE INTESTINAL TRACT WITH SPECIAL REFERENCE TO THE POSSIBLE EFFECTS ON PROTEIN AND FAT DIGESTION AND ON THE METABOLISM OF THE LIVER CELL
F. F. Boyce and E. M. McFetridge. *Surgery* 4, 51 (1938)

In all the dogs the digestion of fat and protein even on a diet rich in these substances was approximately normal after exclusion of the external pancreatic secretion from the intestinal tract.
327. THE LIVER LIPIDS AND FECAL EXCRETION OF FAT AND NITROGEN IN DOGS WITH LIGATED PANCREATIC DUCTS
Elaine P. Ralli, Saul H. Rubin and Clara H. Present. *Am. J. Physiol.* 122, 43 (1938)

The lipid absorption in normal dogs is 97%, whereas in the pancreatic duct ligated dogs it fell to 73%. The duct ligated dogs (3) showed fatty livers and lost $\frac{1}{3}$ of their weight after 14 weeks.
328. DIGESTION AND ABSORPTION OF LIPIDS IN DEPANCREATIZED DUCKS OR DUCKS WITH BLOCKED PANCREATIC EXCRETION
G. C. Morando and D. Montaldo. *Arch. di Fisiol.* 38, 343 (1938)

Ducks survive the removal of the pancreas for a long time without a disturbance in the carbohydrate metabolism.

In ligated duct ducks oleic acid is absorbed better than olive oil, though both to a lesser extent than in normal animals.

After pancreatectomy the absorption of neutral fat is stopped.

It is suggested that the endocrine function of the pancreas (not only its external secretion) enhances fat absorption.
329. CYSTIC FIBROSIS OF THE PANCREAS, VITAMIN A DEFICIENCY AND BRONCHI - ECTASIS
D. H. Andersen. *J. Pediatrics* 15, 763 (1939)

Pancreatin was fed in addition to a diet that contained 20-40% more calories than the requirement for a celiac diet; improvement was noted.

330. SUBSTITUTION THERAPY IN EXPERIMENTAL PANCREATIC DEFICIENCY

R. J. Coffey, F. C. Mann and J. L. Bollman. *Am. J. Dig. Dis.* 7, 149 (1940)

The utilization of fat which had been markedly decreased after pancreatectomy or evulsion of the pancreatic ducts was not materially influenced by administration of pancreatic juice, lipocaic, pancreatin, trypsin, taka diastase and bile salts orally or by way of jejunal fistula.

331. THE INFLUENCE OF THE PANCREAS ON THE UTILIZATION OF FOOD STUFFS

R. J. Coffey, F. C. Mann and J. L. Bollman. *Am. J. Dig. Dis.* 7, 144 (1940)

Gross alterations of the digestive functions in dogs appear only in the complete absence of the external pancreatic secretion.

Complete pancreatectomy, complete pancreatic fistula or evulsion of the pancreatic ducts produced a marked loss of fat in the feces.

A bibliography on the subject is presented.

332. A PRACTICAL TEST OF PANCREAS FUNCTION WITH IODIZED OIL

T. Tremolieres. *Rev. Med.* 57, 1 (1940). C. A. 6313 (1940)

The digestion and absorption of iodized oil is measured by the urine iodine excretion.

It is shown that the excretion is much diminished in pancreatic disturbances.

333. OBSERVATIONS ON THE PATHOLOGIC PHYSIOLOGY OF THE INSULAR AND EXTERNAL SECRETORY FUNCTIONS OF THE HUMAN PANCREAS

A. O. Whipple, L. Bauman and M. Hamlin. *Am. J. Med. Sci.* 201, 629 (1941)

Three cases in which the head of the pancreas and the duodenum were removed for carcinoma were studied. In one case it was shown at autopsy that no pancreatic juice got into the intestine.

In two of the patients fat absorption appeared normal. The third one had to be fed pancreas for normal absorption.

334. OCCLUSION OF THE EXTERNAL PANCREATIC SECRETION IN MAN

A. Brunschwig and J. Allen. *Proc. Soc. Exp. Biol. and Med.* 53, 43 (1943)

A patient with the external secretion of the pancreas occluded showed normal fat absorption, and two others showed a marked decrease in the absorption of fat. No explanation is given.

335. THE EFFECT OF DIETARY COMPOSITION ON PANCREATIC ENZYMES

M. I. Grossman, Harry Greengard and A. C. Ivy. *Am. J. Physiol.* 138, 676 (1943)

Rats were maintained for three weeks on a constant diet, and adaptation of the composition of chief pancreatic enzymes to the predominant constituent of the diet was noted. Thus on a high carbohydrate diet there was a pronounced increase in amy-

lase, together with a decrease in trypsin. A high protein diet resulted in greatly increased trypsin content and a less extensive, but definite, increase in lipase. On a high fat diet there were essentially no alterations in lipase or trypsin.

A diet which is high in fat and low in protein causes a repression of all pancreatic enzyme formation. The addition of 1% choline to such a diet increases uniformly the content of all enzymes.

336. POST-OPERATIVE ACHYLIA PANCREATICA: FAT AND PROTEIN ABSORPTION WITH AND WITHOUT REPLACEMENT THERAPY (REPORT OF A CASE)

M. Lake, N. W. Cornell and H. E. Harrison. *Am. J. Med. Sci.* 205, 118 (1943)

Total absence of the pancreatic enzymes from the intestine after resection of the head of the pancreas was demonstrated. A marked loss of fat, nitrogen and calcium occurred.

Pancreatic enzyme therapy improved the absorption of fat and vitamin A materially.

The findings during a period of obstructive jaundice suggests that pancreatic enzymes are active in the absence of bile and that the former are relatively more important for fat utilization than the latter.

337. DISEASES OF THE PANCREAS

A. O. Whipple. *Nelson's Loose Leaf Living Med.* 5, 531 (1946?)

It is shown that in partial and complete pancreatectomy of patients in most cases fat absorption was normal. Pancreatic juice, therefore, does not seem essential in fat digestion.

338. METABOLIC STUDIES IN PATIENTS WITH CANCER OF THE GASTRO-INTESTINAL TRACT. V. PANCREATIC INSUFFICIENCY IN A PATIENT TREATED SURGICALLY FOR CARCINOMA OF THE AMPULLA OF VATER.

P. E. Rekers, G. T. Pack and C. P. Rhoads. *J. Am. Med. Assn.* 122, 1243 (1943)

Administration of pancreatic enzymes decreased the amount of fat in the feces. An increased protein intake resulted also in increased absorption of fat. An increase of fat in the diet resulted in increased fat absorption but not in a lessening of fecal fat.

339. THE EFFECT OF PANCREATECTOMY ON FAT ABSORPTION FROM THE INTESTINES

C. Vermeulen, F. Owens and L. R. Dragstedt. *Am. J. Physiol.* 138, 792 (1943)

Measurement of fat absorption by: (1) total lipids in blood serum.
(2) fat in feces.

Fat feeding does not produce temporary hyperlipemia as in normal dogs, not even when raw pancreas or pancreatic juice is fed. The absorption of neutral fat is found to be less, but results vary widely. Also the absorption of fatty acid is said to be slower.

340. ON THE QUESTION OF THE INTERNAL FUNCTION OF THE PANCREAS WITH RESPECT TO FAT METABOLISM

U. Lombroso. Arch. Exp. Path. u. Pharm. 56, 357 (1907)

Fecal fat in the depancreatized dog is not found to be diminished after administration of pancreatic juice. The melting point of the fecal fat was often found higher than that of the ingested fat, and the amounts were also higher sometimes.

It is concluded that the internal function of the pancreas is necessary for proper fat (exogenous or endogenous) metabolism.

341. THE ROLE OF THE PANCREAS IN THE ABSORPTION OF FOOD FROM THE INTESTINE

R. Fleckseder. Arch. Exp. Path. u. Pharm. 59, 407 (1908)

It is claimed that in the dog the absorptive capacity of the intestinal wall depends mostly upon the internal secretion of the pancreas. In the completely depancreatized dog such a compensation may occur that absorption is not retarded more than in the pancreatic duct ligated dog.

342. ON THE FAT METABOLISM IN THE ABSENCE OF PANCREATIC JUICE FROM THE INTESTINE

B. C. P. Jansen. Z. f. Physiol. 25, 105 (1911)

In a dog the pancreas was partially removed and the other part transplanted. Fat absorption took place to the extent of 75%. Then the transplanted pancreas was removed and fat absorption fell to 20-30%.

344. DOES THE INTERNAL SECRETION OF THE PANCREAS INFLUENCE FAT ABSORPTION?

H. Light and A. Wagner. Klin. Wochschr. 6, 1982 (1927)

Insulin was tested on depancreatized dogs and patients; it was found that it does not influence fat absorption. Dogs in which the pancreatic ducts were ligated showed the same insufficiency of fat absorption as depancreatized dogs.

345. ON THE FUNCTION OF PANCREASES AS ENDOCRINE GLAND IN FAT ABSORPTION

M. U. Lombroso. Ann. physiol. physicochim. biol. 16, 298 (1940). C. A. 6294 (1941)

Emulsified olive oil was absorbed from vella fistula in a normal but not in a depancreatized dog. Fatty acids were absorbed at the same rate in normal dogs; more unsaturated fats were absorbed much less. It is concluded that hydrolysis of fats is not absolutely necessary for fat absorption and that the pancreas can influence fat absorption by its endocrine function.

346. DETERMINATION OF PANCREATIC LIPASE

R. Willstätter, E. Waldschmidt-Leitz and F. Memmen. Z. physiol. Chem. 125, 93 (1923)

The hydrolytic activity of pancreatic lipase was studied under different conditions

of pH, with the addition of activators and inhibitors.

347. ON THE ACTION OF PANCREATIC LIPASE ON DIFFERENT SUBSTANCES

R. Willstatter and F. Memmen. Z. Physiol. Chem. 133, 229 (1924)

The action of pancreatic lipase on olive oil, methylbutyrate, and triacetin has been studied.

348. COMPARISON OF LIPASES FROM THE STOMACH AND PANCREAS

R. Willstatter and F. Memmen. Z. physiol. Chem. 133, 247 (1924)

It is found that the two lipases act similarly.

349. THE DIGESTION OF FAT FROM THE CELLS OF THE SOYBEAN AND EVIDENCE FOR THE PENETRATION OF LIPASE THROUGH THE INTACT CELL MEMBRANE

W. Heupke. Arch. Verd. Krankh. 51, 2 (1931). C. A. 3553 (1932)

The fat of soy bean and hazel nuts is dissolved by intestinal juices out of intact cells. Presumably the fats are converted into water soluble soaps.

(See also Nos. 134, 225, 246, 251, 282, 285, 315, 366, 367, 427, 435, 439, 441, 451, 461, and 508.)

B. In Vitro

350. ON A FAT DEHYDROGENATING ENZYME

N. Berend. *Biochem. Z.* 260, 490 (1933)

An enzyme from the pancreas which removes hydrogen from saturated fatty acids is isolated. Demonstration, determination and properties of the enzyme are discussed.

351. AN APPARATUS FOR THE PRODUCTION OF FINELY DISPERSED EMULSIONS, AND THE RATE OF DIGESTION OF FAT BY LIPASE IN RELATION TO THE SURFACE AREA

A. C. Frazer and V. G. Walsh. *J. Physiol.* 78, 467 (1933)

An apparatus is described for the production of highly dispersed emulsions of oil in water, the particles of which are of the magnitude of $1/2$ or less.

The rate of digestion of fat by lipase is proportional to the surface area exposed by the particles and inversely proportional to the radii of the globules.

In a very finely divided emulsion the reaction curve approximates that of a substance in true solution.

352. SPLITTING OF HARDENED OILS BY PANCREATIC LIPASE

F. Tofte. *Biochem. Z.* 272, 308 (1934)

Hardened whale oil and soybean oil were split by the lipase with a velocity inversely proportional to the hardness of the fat. The iodine number does not influence the reaction velocity directly but is only important in as far as it affects the melting point.

353. THE FORMATION OF INTERMEDIATE PRODUCTS IN THE PANCREATIC DIGESTION OF FAT

C. Artom and L. Reale. *Boll. Soc. Ital. Biol. Sper.* 10, 883 (1935). C. A. 2625 (1936)

An aqueous extract of dog pancreas was used for in vitro reactions. Acetyl number determinations indicated that intermediates of incomplete saponification are formed.

354. THE FORMATION OF INTERMEDIATE PRODUCTS IN THE PANCREATIC DIGESTION OF NEUTRAL FAT

C. Artom and L. Reale. *Arch. Sci. Biol. (Italy)* 21, 368 (1935). C. A. 7656 (1936)

355. THE INFLUENCE OF STATE OF DIVISION OF THE TRIGLYCERIDE UPON THE RATE OF HYDROLYSIS

K. Holwerda, P. E. Verkade and A. H. A. de Willigen, *Rec. Trav. Chim.* 55, 43 (1936). C. A. 2592 (1936)

It is shown that the rate of hydrolysis by pancreatic extract of tricaprylin, trinonylin, tricaprin, and triundecylin is directly related to the state of division.

356. THE INFLUENCE OF DOUBLE LINKAGES AND OF FREE ALCOHOLIC GROUPS ON PANCREATIC DIGESTION OF GLYCERIDES OF HIGH FATTY ACIDS

G. Peretti. *Arch. di Fisiol.* 36, 113 (1936). C. A. 7656 (1936)

The digestibility decreases in the following sequence: coconut oil (iodine value 13), olive oil (83), peanut oil (102), sesame oil (103), corn oil (124). It increases again from papaver oil (128) to sunflower oil (136) and linseed oil (182). Olive oil is digested slightly faster than glycerol mono-oleinate and dioleinate.

357. THE HYDROLYSIS OF GLYCERIDES BY CRUDE PANCREAS LIPASE

A. K. Balls, M. B. Matlack and I. W. Tucker. *J. Biol. Chem.* 122, 125 (1937)

The hydrolysis of tristearin with pancreatic lipase has been carried to practical completion. The hydrolysis of monostearin proceeds faster. The fat residue of partially hydrolyzed tristearin when extracted with alcohol and ether was found to consist almost entirely of tristearin and no monostearin.

358. IN VITRO DIGESTION OF FATS

N. N. Dastur and K. V. Giri. *Proc. Soc. Biol. Chem. India* 1, 40 (1937). C. A. 7449 (1937)

Pancreatic lipase hydrolyses butter fat and coconut oil. The rate is accelerated by Na-taurocholate. The latter has no effect on the hydrolysis of sesame and ground nut oils. These studies were done in vitro.

359. RELATIVE DIGESTIBILITIES OF EDIBLE FATS BY CASTOR-SEED AND PANCREATIC LIPASES

N. N. Dastur and K. V. Giri. *Indian J. Med. Research* 25, 427 (1937). C. A. 7449 (1937)

The optimum pH for hydrolysis of butter fat by castor bean lipase is NaOAc-HOAc buffer was 4.7-4.4. At this pH coconut oil, sesame oil and ground-nut oil were decomposed less readily than butter fat. In $\text{NH}_4\text{OH-NH}_4\text{Cl}$ buffer pancreatic lipase exhibited maximum activity at pH 8.6; in glycine buffer, at pH 9.3 and 12.6. The order of relative digestibility of fats at pH 9.6 was reversed at 12.6. The digestion of butter fat and coconut oil by pancreatic lipase was accelerated by Na-taurocholate, while the hydrolysis of sesame and ground-nut oils was not affected. The digestion of all the fats by castor-bean lipase was inhibited by Na-taurocholate. Of the oils investigated butter fat formed the most stable emulsions during digestion.

360. A NOTE ON THE DIGESTION OF FATS BY PANCREATIC LIPASE

G. A. Hartwell. *Biochem. J.* 32, 462 (1938)

Coconut oil was digested by pancreatic lipase more rapidly than any other fat.

Palm kernel oil and castor oil were digested more rapidly than butter fat, while almond oil, arachis oil, bacon fat, beef fat, beef oleo, beef stearin, cocoabutter, cod liver oil, cottonseed oil, lard, mutton fat, olive oil, palm oil, premier jus, soya bean oil, hardened whale oil and hardened arachis oil were digested appreciably more slowly and at approximately equal rates.

361. THE EFFECT OF REFINING ON THE DIGESTIBILITY OF EDIBLE OILS AND FATS

F. G. T. Menezes and B. N. Banerjee. *J. Indian Inst. Sci.* 22A, 203 (1939)

The digestion of several oils (coconut oil, ground nut oil, cottonseed oil, gingili oil) was determined with pancreatic lipase.

In general it is found that the process of refining, deodorization and hydrogenation retards the digestion to a more or less extent, presumably because the natural activators are lost.

362. THE FORMATION OF LOWER GLYCERIDES DURING THE HYDROLYSIS OF TRIGLYCERIDE WITH PANCREATIC JUICE

A. C. Frazer and H. G. Sammons. *Biochem. J.* 33, PXX (1944)

Olive oil was treated with pancreatic lipase. At the end of 4 hours 20-25% of the glycerides were found to be lower glycerides (monoglycerides). It is pointed out that the system bile salt/fatty acid/monoglyceride provides an emulsifying system for neutral fat not affected over a pH range of 5.0-9.0.

363. THE FORMATION OF MONO- AND DI-GLYCERIDES DURING THE HYDROLYSIS OF TRIGLYCERIDE BY PANCREATIC LIPASE

A. C. Frazer and H. G. Sammons. *Biochem. J.* 39, 123 (1945)

No significant glycerol destruction can be demonstrated during the first 5 hours of pancreatic lipolysis. No free glycerol can be demonstrated, even though the acetyl value changes from 5 to 64. Material recovered from the intestines of a group of 12 rats shows a proportion of lower glycerides comparable to the *in vitro* experiments. The latter can be separated with phthalic anhydride. An emulsifying system for fat which is effective under the conditions prevailing in the intestine is the triple combination fatty acid/bile acid/lower glyceride. One of the functions of lipolysis would appear to be the formation of two of the three essential factors for emulsification. The formation of lower glycerides is not a result of low potency of the lipase.

363A. STUDIES ON THE DIGESTIBILITY OF EDIBLE OILS AND FATS. II. THE EFFECT OF STEROLS, CAROTENE, AND VITAMINS ON PANCREATIC LIPASE

F. G. T. Menezes and B. N. Banerjee. *J. Indian Inst. Sci.* 27A, 7 (1945). C. A. 3338 (1946)

Carotene, calciferol, and cholesterol activated the digestion of the oils by pancreatic lipase, whereas thiamin and ascorbic acid did not exert a significant influence on lipase activity.

(See also Nos. 283 and 397.)

XIII. ACTION OF BILE ON FATS (364-407)

A. In Vivo

B. In Vitro

A. In Vivo

364. THE ABSORPTION OF FATS BY MAKING THEM SOLUBLE IN WATER

E. Pfluger. Arch. Physiol. Pflug. 86, 1 (1901)

A discussion of the role of alkali and bile is presented.

365. CONTINUED INVESTIGATIONS ON THE ABSORPTION OF FATS IN AQUEOUS SOLUTIONS

E. Pfluger. Arch. Physiol. Pflug. 88, 299 (1901)

The importance of sodium carbonate and bile acids in fat absorption is discussed.

366. FAT AND NITROGEN METABOLISM IN A CASE OF CONGENITAL ABSENCE OF THE BILE-DUCTS WITH A STUDY OF FERMENTS OF THE PANCREATIC SECRETION AND THE FECES

Henry Koplik and Burrill B. Crohn. Am. J. Dis. Child. 5, 36 (1913)

Fat metabolism is greatly disturbed, being characterized by poor absorption and deficient splitting of neutral fats.

The pancreatic ducts are patent and the pancreatic secretion is of normal strength.

The lipolytic ferment of the pancreas, while present, performs its function weakly on account of the absence of the bile salts, which normally accelerate its enzymatic activity.

The study was made on an infant.

367. THE DIGESTION AND ABSORPTION OF FATS IN A CASE OF CONGENITAL ATRESIA OF THE BILE DUCTS

H. S. Hutchinson and G. B. Fleming. Glasgow Med. J. 94, 65 (1920)

No bile could enter the gut. The digestion of fat by fat splitting was only slightly inhibited. Fat absorption was greatly decreased.

368. THE PHYSIOLOGICAL ACTION BILE SALTS

J. Pohl. Z. Exp. Med. 30, 423 (1922)

The properties of many different bile acids are discussed. It is shown that cholic acid and desoxycholic acid stimulate fat absorption in the rabbit.

369. BILE SALTS AND SECRETIN AS CHOLAGOGUES

J. Mellanby. J. Physiol. 64, 331 (1928)

The injection of bile into the duodenum causes a large secretion of pancreatic juice and augments the secretion of bile.

The intravenous injection of bile salts augments the flow of bile but has no effect on pancreatic secretion.

These facts show that (a) bile salts, free from secretin, absorbed into the blood from the small intestine act as cholagogues; (b) the action of secretin as a cholagogue is

secondary to its action on the pancreas.

370. ON THE RELATION OF THE BILE ACIDS TO FOOD CHOLESTEROL

K. Loeffler. *Z. physiol. Chem.* 178, 186 (1928)

Mice fed cholesterol show a slow accumulation of cholesterol in the liver. When in addition, cholic acid or desoxycholic acid is fed, the increase is much faster and proceeds to a much higher level. Cholic acid is more effective in this respect than desoxycholic acid.

371. ON THE RELATIONS OF BILE ACIDS TO DIETARY CHOLESTEROL

R. Hemmel. *Z. physiol. Chem.* 185, 105 (1929)

All bile salts are able to facilitate the absorption of dietary cholesterol.

372. THE SIGNIFICANCE OF PAIRED BILE ACIDS FOR FAT ABSORPTION. IV.

F. Verzar and A. Kuthy. *Biochem. Z.* 230, 451 (1931)

It is shown that in the dog a certain amount of bile is more efficient in making fatty acids diffusible than it is in vitro. It is supposed that the bile acids are absorbed on the epithelial cells of the intestine and that their function is to make fatty acids water soluble on that surface.

373. ON THE RATIO OF CHOLIC ACID TO FAT IN THE INTESTINE AND ITS RELATION TO FAT ABSORPTION

Otto Furth and Harald Minibek. *Biochem. Z.* 237 139 (1931)

The ratio of cholic acid to fat in the intestines of children, cats and rats was determined.

It was found that in rats the amount of bile is enough to dissolve all the fat, whereas in children and cats the amount is less favorable for complete solution if it is assumed that the bile is not available for reutilization.

374. ON THE BILE ACIDS IN THE FECES AND THEIR RELATION TO FAT ABSORPTION IN CHILDREN

H. Minnibeck. *Biochem. Z.* 257, 160 (1933)

The bile-to-fat ratio in feces is much less than in the intestine, even though the former increases in intestinal disturbances.

375. THE ROLE PLAYED BY BILE IN THE ABSORPTION OF VITAMIN D IN THE RAT

J. D. Greaves and C. L. A. Schmidt. *J. Biol. Chem.* 102, 101 (1933)

Little or no irradiated ergosterol is absorbed from the intestinal tract of a rat with a bile fistula.

Desoxycholic acid when administered by mouth can serve as a carrier of irradiated ergosterol across the intestinal wall of the rat with a bile fistula.

376. SIGNIFICANCE OF THE LIVER IN THE METABOLISM OF LIPOIDS. CHANGES IN LIPOIDS IN THE BLOOD AND BILE WHEN VARIOUS KINDS OF BILE ACIDS ARE ADMINISTERED

Y. Asoda. *Japan J. Gastroenterol.* 6, 1 (1934). C. A. 5511 (1934)

The Na salts of the various bile acids were fed to rabbits in 1% aqueous solution (20 cc. per kg.). The lipid fractions of the blood decreased temporarily, while those of bile increased.

377. ALKALI RESERVE AND CALCIUM OF BLOOD; UTILIZATION OF FAT AFTER COMPLETE EXTERNAL DRAINAGE OF BILE: AN EXPERIMENTAL STUDY

M. Agrifoglio and M. Canavero. *Arch. Ital. di Chir.* 37, 594 (1934)

378. INVESTIGATIONS ON THE ABSORPTION OF FATTY ACIDS

F. Verzar and L. Laszt. *Biochem. Z.* 270, 24 (1934)

- 1) Glycocholic acid and taurocholic acid increase the absorption of oleic acids in rats.
- 2) Glycerine or phosphate does not increase the absorption of oleic acid but a mixture of the two does. This increased absorption can be inhibited by moniodoacetic acid.

379. FAT ABSORPTION IN INVERTEBRATES THROUGH SURFACE ACTIVE MATERIALS

H. J. Vonk. *Acta Brevia Neerlandica* 5, 12 (1935)

A discussion of the action of the digestive juices of the crayfish on fats is presented. It is thought likely that surface-active substances play the same part in the fat absorption of invertebrates as does bile in the vertebrates.

380. D. Moggi. *Riv. Clin. Ped.* 32, 257 (1934). *Ann. Rev. Biochem.* 4, 200 (1935)

In three cases of congenital total atresia of the bile duct, it was found that from 28 to 55% of the ingested fatty acids were excreted in the feces.

381. THE INFLUENCE OF NA TAUROCHOLATE, HEPATIC BILE, AND GALL BLADDER BILE UPON THE ABSORPTION OF OLEIC ACID FROM THE SMALL INTESTINE

Cecilia Riegel, K. O'Shea Elsom and I. S. Ravdin. *Am. J. Physiol.* 112, 669 (1935)

Isolated jejunal loops of dogs were made according to Johnston.

The four dogs differed appreciably in their response to a given procedure. It was found that the absorption of oleic acid alone is not appreciable. The absorption is greatly increased by the presence of Na taurocholate, and somewhat less by hepatic and gall bladder bile in the loop.

382. ON THE ABSORPTION AND UTILIZATION OF CAROTENE AND VITAMIN A IN CHOLE-DOCHOCOLONOSTOMIZED VITAMIN A DEFICIENT RATS

J. D. Greaves and L. Schmidt. *Am. J. Physiol.* 111, 492 (1935)

In confirmation of previous work on icteric rats, it is shown that vitamin A, when fed orally, is absorbed in sufficient amounts by the rat with an internal bile fistula to correct the vaginal smear picture.

The operated animals showed a positive response to carotene when this substance was administered along with glycodesoxycholic or desoxycholic acid.

The experiments indicate that these bile acids can function as carriers of carotene across the intestinal tract of the rat.

383. THE INFLUENCE OF CERTAIN HYDROTROPIC AND OTHER SUBSTANCES UPON FAT ABSORPTION

Margaret House Irwin, Janet Weber and H. Steenbock. *J. Nutr.* 12, 305 (1936)

Rats were fed 1.5 cc. melted fat by stomach tube. Immediately after this a 1 cc. water solution of bile salts, sodium benzoate, ethyl alcohol, peptone, sucrose, KCl, CaCl_2 , NaH_2PO_4 , glycerol, Na glycerophosphate was given. Small amounts had little or no effect on the amount of fat absorbed 4 hours after ingestion, but larger amounts decreased the rate of absorption. The base fat fed was a commercially hydrogenated vegetable shortening.

384. RELATION OF CERTAIN BILE ACIDS TO ABSORPTION OF B-CAROTENE IN THE RAT

J. D. Greaves and C. L. A. Schmidt. *Proc. Soc. Exp. Biol. and Med.* 36, 434 (1937)

No chemical evidence was obtained that taurocholic acid, glycocholic acid, and decholin form compounds with B-carotene. When B-carotene, together with taurocholic acid, glycocholic acid, or decholin, was fed to bile fistula, vitamin A deficient rats, the B-carotene was not utilized. When B-carotene, in the form of a suspension, was injected intravenously, it was less effective than when administered orally. A less marked difference was noted in the case of vitamin A.

385. RELATION OF BILE TO ABSORPTION OF VITAMIN E IN THE RAT

J. D. Greaves and C. L. A. Schmidt. *Proc. Soc. Exp. Biol. and Med.* 37, 40 (1937)

The evidence indicates that administration of desoxycholic acid increases the availability of vitamin E, when given orally, in the bile fistula rat.

386. ABSORPTION OF FAT FROM THE ILEUM IN HUMAN BEINGS

Henry Doubilet and Mirian Reiner. *Arch. Int. Med.* 59, 857 (1937)

The experiment was performed on a loop of small intestine of a patient with a strangulated femoral hernia. The conclusion cannot be firmly established, since only one subject was experimented on.

It was found that the middle of the ileum secretes a fluid containing 2% lipids. Bile acids do not change the lipid concentration but increase the volume secreted. Olive oil and oleic acid (after injection into the intestinal loop) are absorbed without the addition of bile acids, and the latter, added in small amounts, do not increase their

rate of absorption. Desoxycholic acid increases the volume of excretion; therefore it reduces the rate of fat absorption.

387. BILE SALTS AND FAT ABSORPTION

L. A. Crandall and H. B. Ivy. *Rev. Gastroenterol.* 7, 300 (1940)

The rise in blood fat after the administration of 150 ml. water and 100 ml. olive oil to dogs with internal bile fistula was taken as the criterion of fat absorption.

No rise in blood fat was noticed with this standard meal with or without addition of dehydrocholic acid, or glycocholic acid. The addition of 3 gm. of commercial bile salts, desoxycholic or taurocholic acid was very effective in promoting fat absorption.

388. THE EFFECT OF THE EXCLUSION OF BILE ON THE ABSORPTION OF FOODSTUFFS

R. J. Coffey, F. C. Mann and J. L. Bollman. *Am. J. Dig. Dis.* 7, 143 (1940)

When bile was excluded from the intestine of a dog there was a definite diminution of the absorption of fat. Carbohydrate utilization was not impaired. There was an increased loss of nitrogen, which was independent of the amount of protein in the diet but proportional to the bulk of the feces.

389. GASTROINTESTINAL TRACT MOTILITY IN THE ABSENCE OF BILE

R. F. Ackerman, H. Curl and L. A. Crandall. *Am. J. Physiol.* 134, 32 (1941)

After a fat meal the stomach of the dog with a bile fistula empties more slowly; this can be corrected by the addition of bile salts.

Bile salts do not seem to be an important factor in small intestinal motility, however.

390. PRELIMINARY REPORT OF THE COUNCIL

T. G. Klumpp. *J. Am. Med. Assn.* 117, 361 (1941)

A consideration of the available data indicates that bile salts are essential for absorption of fat and fat soluble vitamins; evidence that one particular bile acid is responsible is less convincing.

391. EFFECT OF BILE AND BILE SALTS ON ABSORPTION OF SODIUM OLEATE FROM JEJUNAL LOOPS OF DOGS

R. W. Virtue, M. E. Doster-Virtue, D. I. Smith and J. Greenblott. *Am. J. Physiol.* 135, 776 (1942)

Na-oleate was absorbed to an appreciable extent. Gall bladder bile enhanced the absorption but Na-taurocholate and Na glycocholate separately or together did not promote absorption in the concentrations used.

392. WHIPPLE'S DISEASE OR INTESTINAL LIPODYSTROPHY

H. E. Pearse. *Surgery* 11, 906 (1942)

Data are presented which suggest that the abnormal fat digestion is due to a fault

in bile salt metabolism. The clinical response to bile salt administration is favorable.

393. LIPOID METABOLISM - RELATION OF HYPERLIPEMIA DUE TO OBSTRUCTION OF
CHOLEDOCHUS TO ABSENCE OF BILE IN INTESTINE

C. Jimenez-Diaz and H. Castro-Mendoza. Rev. Clin. Espan. 4, 398 (1942)

394. THE PRESENCE OF A BILE ACID IN THE DIGESTIVE JUICE OF THE RIVER CRAY-
FISH AND ITS SIGNIFICANCE IN FAT ABSORPTION

H. J. Vonk. Proc. Nederland Akad. Wetensch. 45, 752 (1942). C. A. 4040 (1944)

395. OBSERVATIONS IN TOTAL BILIARY-FISTULA DOGS WITHOUT BILE THERAPY

C. C. Scott. Am. J. Physiol. 144, 626 (1945)

The necessity of bile for the life of the animals with bile fistula appears to reside largely in its facilitating the absorption of fat-soluble vitamins.

(See also Nos. 89, 134, 136, 137, 246, 247, 251, 286, 330, 336, 403, 438, 467, 468, 470, 476, 480, 496, 561, and 575.)

B. In Vitro

396. ON THE HYDROLYSIS, MEDICATED BY BILE, AND THE DETERMINATION OF SOAPS AND FATTY ACIDS IN MIXTURES WITH BILE ACIDS

E. Pfluger. Arch. Physiol. Pflug. 90, 1 (1902)

397. ON THE EFFECT OF BILE UPON THE HYDROLYSIS OF ESTERS BY PANCREATIC JUICE

A. S. Loevenhart and C. G. Souder. J. Biol. Chem. 2, 415 (1906)

Bile salts, lecithin, and bile greatly accelerate the action of pancreatic juice on all of the esters studied, including olive oil.

Different specimens of juice and different experimental conditions altered greatly the degree of acceleration observed and the relative activity of the bile salts and lecithin.

398. ON THE SIGNIFICANCE OF THE BILE ACIDS IN FAT ABSORPTION

F. Verzar and A. Kuthy. Biochem. Z. 205, 369 (1929)

It is shown that paired bile acids are important because they make possible the solution of fatty acids at neutral or acid pH, whereas soaps are not soluble at the pH of the intestine.

399. THE COMBINATION OF PAIRED BILE ACIDS WITH FATTY ACIDS AND ITS SIGNIFICANCE FOR FAT ABSORPTION

F. Verzar and A. Kuthy. Biochem. Z. 210, 265 (1929)

The changes in surface tension at different pH are measured. It is suggested that bile acids form complexes with oleic, stearic, palmitic acids when the pH is neutral or slightly acid.

400. THE COMBINATION OF PAIRED BILE ACIDS WITH FATTY ACIDS AND ITS SIGNIFICANCE FOR THE FAT ABSORPTION

F. Verzar and A. Kuthy. Biochem. Z. 210, 281 (1929)

It was found that the surface tension measurements at different pH's gave an indication that there exist specific water soluble complexes between oleic, stearic, palmitic acid and paired bile acids at neutrality or down to pH of 6.25, which have a minimal surface tension.

401. ON THE INFLUENCE OF BILE SALTS ON DIFFUSION AND ABSORPTION PHENOMENA

Otto Furth and Rudolf Scholl. Biochem. Z. 222, 430 (1930)

The penetration of lipid soluble substances in gelatin, agar-agar, filter paper, and earthen ware plates was much faster in the presence of bile salts than without them.

This is held to be the explanation of the role of bile in fat absorption.

402. THE SOLUBILITY OF FATTY ACIDS IN BILE WITH PHOSPHOLIPIDS

E. Szorenyi. *Biochem. Z.* 249, 182 (1932)

Lecithin has no influence on the solubility of oleic acid in solutions of paired bile acids. The diffusion of oleic acid in those solutions is also not influenced by 0.8% lecithin.

403. ON THE QUESTION OF THE INFLUENCE OF LECITHIN ON THE SOLUBILITY OF OLEIC ACID IN BILE ACID SOLUTIONS

A. Muller. *Biochem. Z.* 249, 189 (1932)

The presence of lecithin does not explain why the bile in the intestine dissolves more fatty acid than in vitro.

404. ON THE DIFFUSION OF LECITHIN CONTAINING SUSPENSIONS OF FATTY ACIDS AND THE COMPLEX FORMATION OF FATTY ACID, LECITHIN AND BILE ACIDS

O. Furth, J. Breuer and H. Hermann. *Biochem. Z.* 271, 233 (1934)

It is shown that the presence of lecithin in suspensions of iodinated fatty acid and bile interfered somewhat with the diffusibility of the fatty acid complex, even though the lecithin transforms the turbid solution into a clear one.

405. FAT ABSORPTION AND DIALYSIS OF FATTY ACIDS

F. L. Breusch. *Biochem. Z.* 293, 280 (1937)

A good discussion of three different theories of fat absorption is given. Contrary to the results of Verzar and Kuthy, it is found that the higher saturated fatty acids do not under any circumstances diffuse through parchment. The lower fatty acids are found diffusible. The unsaturated fatty acids are found to be more diffusible. The soaps are found to diffuse rapidly but are slowed by the addition of bile salts.

406. CAN OLEIC ACID DISSOLVE IN BILE ACIDS DIFFUSE THROUGH PARCHMENT?

H. J. Vonk, Chr. Engle, C. Engel. *Biochem. Z.* 295, 171 (1938)

It is found that diffusion does not occur.

407. PHYSIOLOGICAL ROLE OF BILE SALTS. INFLUENCE OF BILE SALTS ON THE PASSAGE OF FAT ACIDS THROUGH DIALIZING MEMBRANES

M. A. Macheboeuf and R. Perrimond-Trouchet. *Compt. rend soc. biol.* 132, 274 (1939).
C. A. 1691 (1940)

The soluble compounds formed from higher fat acids and glycocholic acid at pH 6.3 do not diffuse through collodion membranes.

(See also Nos. 252, 283, 287, 358, 362, and 363.)

XIV. ROLE OF THE ADRENALS IN FAT ABSORPTION (408-426)

408. THE RETARDATION OF FAT ABSORPTION BY PHLORIZIN AND ADRENALECTOMY

F. Verzar and L. Laszt. Schweiz. Mediz. Wochschr. 15, 1178 (1934)

Olive oil and lard are practically not absorbed by adrenalectomized rats or by rats poisoned with phlorizin or moniodoacetic acid. (Speech)

409. THE RETARDATION OF FAT ABSORPTION AFTER EXTIRPATION OF THE ADRENALS

F. Verzar and L. Laszt. Biochem. Z. 276, 11 (1935)

Fat absorption is very much retarded in rats three days after adrenalectomy.

Usually the animals died 12-24 hours after the feeding of fat.

The fatty acids are thought to be toxic to the adrenalectomized animal.

410. ADRENALS AND FAT ABSORPTION

F. Verzar and L. Laszt. Biochem. Z. 278, 396 (1935)

The fat absorption in rats, impaired by adrenalectomy, is restored to normal by adrenal cortex hormone administration. This is explained by the influence of the adrenals on phospholipid formation.

Adrenalin and ascorbic acid do not restore normal fat absorption.

411. HISTOLOGICAL INVESTIGATIONS ON FAT ABSORPTION AFTER ADRENALECTOMY

F. Verzar and L. Jeker. Arch. Physiol. Pflug. 237, 14 (1936)

The intestinal mucosa does not show fat droplets after fat feeding to adrenalectomized rats. Fatty acids are present to a great extent. This shows that absorption is disturbed because of the failure of the mucosa to resynthesize fat. After eucortin administration the histological picture is normal.

412. ADRENALS AND FAT ABSORPTION

L. Laszt and F. Verzar. Biochem. Z. 288, 351 (1936)

Cortex hormone restores normal fat absorption in adrenalectomized rats; in normal rats it does not increase fat absorption.

Flavin phosphoric acid (vitamin B₂) also restores fat absorption to normal in adrenalectomized rats.

413. SUGAR AND FAT RESORPTION DISTURBANCES AFTER ADRENALECTOMY

B. V. Issekutz, Jr., L. D. Laszt and F. Verzar. Arch. Physiol. Pflug. 240, 612 (1938)

Cats completely absorb large amounts of fat (butter). After adrenalectomy with the same diet, steatorrhea develops and fat absorption is decreased slightly. No details are given about salt content of diet.

414. DISTURBANCE OF FAT ABSORPTION FOLLOWING ADRENALECTOMY IN CATS

L. Laszt and F. Verzar. *Verh. Schweiz. Physiol.* 13, 21 (1938). C. A. 6410 (1939)

Most of the fats of 30-40 gm. of milk or butter were excreted in the feces of adrenalectomized cats.

415. EFFECT OF ADRENALECTOMY ON RATE OF FAT ABSORPTION

Richard H. Barnes, Arne N. Wick, Elmer S. Miller and Eaton M. MacKay

Proc. Soc. Exp. Biol. and Med. 40, 851 (1939)

It is found that the rate of absorption of both methyl esters of corn oil fatty acids and unaltered corn oil are the same for each hour up to 6 hours after feeding. Adrenalectomy has no significant effect on the absorption of either of these two fats.

The difference from the results of Verzar is explained by the following:

- (1) Verzar employed olive oil, which gives more harmful effects - diarrhea.
- (2) In their above experiments no secondary effects of adrenal insufficiency were noted because of the salt regimen.

In this study rats are used, and the amount of fat fed is 0.5 cc. per square decimeter of body surface.

416. A STUDY OF THE EFFECT OF ADRENALECTOMY AND IODOACETIC ACID POISONING ON THE INTESTINAL ABSORPTION OF SPECTROSCOPICALLY ACTIVE FATS

Richard H. Barnes, Elmer S. Miller and G. O. Burr. *Am. J. Physiol.* 126, P 427 (1939)

Linoleic acid of corn oil is converted to the conjugated form by prolonged saponification. Adrenalectomized rats did not show a decreased absorption nor any change in the incorporation in intestinal phospholipid. Iodoacetic acid (toxic doses) produces greatly decreased absorption and a lowering of the amount of tagged fat present in the neutral fat and phospholipids of intestinal mucosa.

418. EFFECT OF ADRENALECTOMY ON FAT ABSORPTION MEASURED BY FAT EXCRETION IN THE STOOL

W. G. Clark and A. N. Wick. *Proc. Soc. Exp. Biol. and Med.* 42, 336 (1939)

Under fairly normal conditions of nutrition, salt solution being supplied as drinking fluid to maintain the adrenalectomized rats, adrenalectomy has no influence on the absorption of fat from the food. With adequate food intakes, the removal of the adrenal glands does not affect the excretion of fat in the stool.

419. THE ADRENALS AND FAT ABSORPTION

Richard H. Barnes, Elmer S. Miller and George O. Burr. *J. Biol. Chem.* 140, 241 (1941)

Conjugated fatty acids of corn oil were used as tagged fatty acids. Absorption expressed as mgm./sqcm. of body surface was found the same in adrenalectomized rats (maintained with salt) and controls. The rate of incorporation of fatty acids into neutral fat and phospholipid of the intestinal mucosa is not affected.

420. THE INFLUENCE OF THE ADRENALS ON THE TRANSPORT OF FAT INTO THE LIVER

Richard H. Barnes, Elmer S. Miller and George O. Burr. J. Biol. Chem. 140, 247 (1941)

Methyl esters of conjugated fatty acids of corn oil are used. It is pointed out that changes in unsaturation may occur in the liver so that they can no longer be differentiated from other body fat.

Adrenalectomized rats which received adequate salt show an impaired ability to deposit absorbed fat in the neutral fat stores of the liver; the rate of phosphorylation into liver phospholipids is not affected.

It seems possible, therefore, that the transport of fatty acids into a tissue may be altered without any change in the role of phosphorylation.

421. THE EFFECT OF ADRENALECTOMY ON FAT ABSORPTION

Lucien Bavetta, Lois Hallman, Barry J. Deuel, Jr., and Paul O. Greeley. Am. J. Physiol. 134, 619 (1941)

Normal and adrenalectomized rats received, water, water plus cortin or Rubin-Krick solution. Inhibition of fat absorption was found in adrenalectomized rats, which improved somewhat after administration of salt solution. Also larger amounts of fatty acids accumulated in the intestine. Both phenomena were restored to normal by administration of cortin. Hydrogenated cottonseed oil was used.

422. THE EFFECT OF ADRENALECTOMY ON THE ABSORPTION OF HYDROGENATED COTTONSEED OIL, CORN OIL, TRIBUTYRIN AND SODIUM BUTYRATE

Lucien A. Bavetta and Harry J. Deuel, Jr. Am. J. Physiol. 136, 712 (1942)

A definite inhibition in the absorption of both hydrogenated cottonseed and corn oils was noted in adrenalectomized rats. Furthermore, larger amounts of fatty acids accumulated in the intestines of such animals as contrasted with the normal. This would indicate that the adrenal glands play a role in the absorption of the longer chain fatty acids. However, the absorption of tributyrin and of sodium butyrate was unaffected by adrenalectomy, which suggests that the absorption of the water soluble fatty acids is probably not dependent on adrenal activity.

The disagreement with the results of Barnes (1942) is ascribed to the fact that younger rats were used by the present authors.

423. ADRENALECTOMY AND THE ABSORPTION OF DIFFERENT FATS

Richard H. Barnes, Irving I. Rusoff and George O. Burr. Proc. Soc. Exp. Biol. and Med. 49, 84 (1942)

No change in rate of absorption was found for corn oil, olive oil, crisco, or mutton tallow. Hydrogenated vegetable oil fed as emulsion with skim milk showed a significant decrease.

Accumulation of free fatty acids in intestine and less "milky" lacteals were observed in all adrenalectomized rats.

424. PHOSPHORYLATION OF FAT IN ABSENCE OF ADRENAL GLANDS AS MEASURED WITH RADIOACTIVE PHOSPHORUS

N. Stillman, C. Entenman, E. Anderson and I. L. Chaikoff. *Endocrinology* 31, 481 (1942)

The results of the present investigation offer direct proof that phosphorylation of fat, as measured by the incorporation of administered radiophosphorus into the phospholipid molecule, is not interrupted in the liver and small intestine of the adrenalectomized rat. The incorporation of P^{32} into phospholipid was observed in adrenalectomized rats, irrespective of whether they were in good condition while maintained on a high NaCl intake or whether they were showing manifestations of adrenal insufficiency.

425. THE EFFECT OF ADRENALECTOMY ON THE ABSORPTION OF THE SHORT CHAIN FATTY ACIDS AND THEIR TRIGLYCERIDES

Lucien A. Bavetta. *Am. J. Physiol.* 140, 44 (1943)

No decrease in absorption of the short chain fats was observed, tricaproin, sodium caproate, and tricaprylin were tested in this respect.

Caprylic and capric acid showed some inhibited absorption. It is suggested that the longer chain fatty acids are removed more slowly from the intestine of the adrenalectomized animal than in the normals.

426. RELATIONSHIP OF THE ADRENAL CORTEX TO THE METABOLISM OF FAT

Dwight J. Ingle. *J. Clin. Endocrinol.* 3, 603 (1943)

In laboratory animals adrenal cortical insufficiency is characterized by a slower-than-normal rate of absorption of fat, a decrease in the amount of fat transported to and deposited in the liver under conditions which normally cause fatty livers, a smaller-than-normal response to ketogenic agents, and a normal or high respiratory quotient. It is not known to what extent these changes are primary in nature and to what extent they are secondary to failures in functions more directly controlled by the cortical hormones. No overdosage effects of the cortical hormones upon these phases of fat metabolism have been noted, except for a depression of the respiratory quotient, which may indicate that an increase in the oxidation of fat has occurred.

(See also Nos. 266 and 453.)

XV. EFFECT OF DISEASE ON FAT ABSORPTION (427-462)

427. CONTRIBUTIONS TO THE QUESTION OF FAT ABSORPTION UNDER PATHOLOGICAL CONDITIONS IN HUMANS AND ANIMALS

M. Adler. Z. Klin. Med. 66, 302 (1908)

Alkalies increase the splitting of fats in gastric intestinal disturbances.

Fried bacon was found more digestible by the diseased intestine than raw bacon.

Addition of "Pankreon" to the diet increases fat splitting and fat absorption.

427A. ON GLYCOSURIA AND FATTY STOOLS IN MORBUS BASEDOWI, ETC.

W. Falta. Z. Klin. Med. 71, 1 (1910)

Disturbances in fat absorption occurred only in a limited number of cases.

428. NOTES ON THE ABSORPTION OF FAT AND PROTEIN IN TYPHOID FEVER

Warren Coleman and Frank C. Gephart. Clinical Colorimetry. Arch. Int. Med. 15, May 15, (1915)

The average total fat loss for all the periods was 6.25 gm., corresponding to a loss of 4.3 per cent. No differences were observed in the percentage absorption of fat in the early and later stages of the fever or up to the end of the first week of convalescence, when the intake was relatively large.

The constant presence of fat and nitrogen in the feces, even in fasting, vitiates to some extent the validity of the results when expressed in percentages.

429. FAT AND PROTEIN UTILIZATION AFTER THE REMOVAL OF AN APPRECIABLE PART OF THE SMALL INTESTINE

O. Schumm and A. Papendieck. Z. physiol. Chem. 131, 54 (1923)

From a patient 370 cm. of the small intestine was removed. The utilization of fat was found to be impaired most. Similar operations performed by other workers seem to give divergent results with respect to food utilization, even in the same patient from day to day.

430. THREE FATAL ADULT CASES OF MALABSORPTION OF FAT

H. L. Blumgart. Arch. Int. Med. 32, 113 (1923)

The small intestine at necropsy showed small granular elevations of the mucosa consisting of phagocytes containing ingested fat.

The mesenteric lymph nodes were noticeably enlarged and hyperplastic and also contained phagocytes with ingested fat.

431. FAT IN FECES

F. S. Fowweather. Br. J. Exp. Path. 7, 15 (1926)

Fecal fat distribution was measured in persons with 1) catarrhal conditions of small intestine, 2) obstructive jaundice, 3) acute pancreatitis, 4) subacute liver atrophy

and cancer of the head of the pancreas, 5) tuberculosis of mesenteric glands, and 6) coeliac disease.

No conclusions about the significance of the results are drawn.

432. ON THE BLOOD FAT LEVEL AND ITS CHANGES AFTER AN OIL BREAKFAST IN HEALTHY AND SICK PEOPLE

R. Leppien. Z. Exp. Med. 81, 728 (1932)

Healthy people showed a normal alimentary lipemia. Liver disease changed the fat absorption and obese people showed an increase height of the lipemic curve as well as a greater fasting blood fat level.

433. CHOLESTEROL AND ABSORPTION AFTER EXTIRPATION OF THE SPLEEN

H. Krejs. Z. Exp. Med. 88, 271 (1933)

Variations in alimentary hyperlipemia and cholesteremia are observed in patients. This is thought to be due to a disturbance in absorption.

434. BLOOD FAT TOLERANCE TESTS IN MALNUTRITION AND OBESITY

H. Blotner. Arch. Int. Med. 55, 121 (1935)

Plasma cholesterol after feeding cream is studied in normal, thin, and obese persons. In the latter the cholesterol is found to increase. Pituitary extract prevents and insulin increases this hyperlipemia.

435. THE DIARRHEA OF DIABETES AND STEATORRHEA OF PANCREATIC INSUFFICIENCY

J. A. Bargaen, J. L. Bollman, and E. J. Kepler. Proc. Staff Meetings Mayo Clin. 11, 737 (1936)

Cases are reported in which pancreatic enzyme therapy had a beneficial effect on fat absorption.

436. THE EFFECT OF LIVER EXTRACT ON THE ABSORPTION OF FAT IN SPRUE

W. H. Barker and C. P. Rhoads. Am. J. Med. Sci. 194, 804 (1937)

Five cases of sprue studied during the presence of intestinal symptoms showed an absence of the normal increase in the levels of fat in the blood after a fat meal.

Three of the five cases were tested after the parenteral administration of liver extract and showed postabsorptive levels of fat in the blood which approached the normal.

The experimental results suggest that in sprue, liver extract exerts some specific effect upon the absorptive power of the intestinal tract.

437. CURVE OF ALIMENTARY LIPEMIA IN PREGNANCY AND PUERPERIUM

A. Bruno. Ann. di Ostet. e. Gynec. 59, 159 (1937)

438. ALIMENTARY LIPEMIA IN NORMAL CONDITIONS AND GALL BLADDER DISEASE
W. Leum. *Beit z. Klin. Chir.* 166, 111 (1937)
439. THE EFFECT OF THE ORAL ADMINISTRATION OF PANCREATIN ON FECAL NITROGEN AND FAT LOSS IN ACHYLIA PANCREATICA
C. R. Schmidt, J. M. Beazell, P. J. Crittenden and A. C. Ivy. *J. Nutr.* 14, 513 (1937)
It is concluded that potent pancreatin, when given in the form of enteric coated tablets and in adequate amount, is significantly effective in reducing nitrogen and fat loss in the feces of dogs having achylia pancreatica.
440. THE SERVICEABILITY OF THE HEMOLIPOCRIT METHOD AND THE COURSE OF ALIMENTARY HYPERLIPEMIA IN NORMAL PERSONS AND IN PATIENTS SUFFERING FROM IDIOPATHIC STEATORRHEA
P. Vogt-Moller and B. Lawaetz. *Acta. Med. Scand.* 92, 105 (1937). C. A. 7996 (1937)
The results show that fat absorption was decreased in the cases of idiopathic steatorrhea.
441. CYSTIC FIBROSIS OF THE PANCREAS AND ITS RELATION TO COELIAC DISEASE
D. H. Andersen. *Am. J. Dis. Child.* 56, 344 (1938)
The frequent occurrence of vitamin A deficiency was probably due to failure of absorption of this vitamin. It is suggested that the pulmonary infection was possibly secondary to vitamin A deficiency.
442. LIPID AND CALCIUM ABSORPTION
L. Brull and G. Barac. *Compt. rend. soc. biol.* 127, 820 (1938)
In patients with steatorrhea both fat and calcium are excreted in excessive amounts.
443. A PECULIAR DISTURBANCE IN FAT RESORPTION AND ITS RELATION TO SPRUE
K. Kloos. *Virch. Arch. f. Path. Anat.* 304, 625 (1939). C. A. 6997 (1940)
444. BEHAVIOR OF LIPEMIA IN VARIOUS PATHOLOGIC CONDITIONS
B. Nolli and A. Bologna. *Clin. Med. (Ital.)* 70, (1939)
445. MALABSORPTION OF FAT (INTESTINAL LIPODYSTROPHY OF WHIPPLE) REPORT OF A CASE
H. L. Reinhart and S. J. Wilson. *Am. J. Path.* 15, 483 (1939)
Intestinal lipodystrophy is characterized by progressive emaciation, chylous ascites, fatty diarrhea, mild hypochromic microcytic anemia, a characteristic anatomical pattern and a fatal termination.

446. ABSORPTION STUDIES IN CHILDREN WITH GIARDIA LAMBLIA INFECTION

P. V. Veghelyi. Arch. Dis. Childhood 14, 155 (1939). C. A. 6943 (1939)

Children of 2-14 years were studied. In 10 of 14 cases fecal fat amounted to 25-79% of the fat intake. 65-80% of the fecal fat was fatty acids or soaps.

447. FAT ABSORPTION IN PATIENTS WITH TRANSDUODENAL FEEDING

F. V. Kepp. Z. Klin. Med. 136, 200 (1939). C. A. 4421 (1940)

Patients suffering from gastric and duodenal ulcers were fed by means of a trans-duodenal tube which was introduced (under X-ray control) into the upper jejunum. From 13 to 43% of the neutral fat administered was passed in the feces. The patients lost weight.

448. DIGESTION AND ABSORPTION IN A MAN WITH ALL BUT THREE FEET OF THE SMALL INTESTINE REMOVED SURGICALLY

Wilbert R. Todd, Marlowe Ditterbrandt, John R. Monrague and Edward S. West. Am. J. Dig. Dis. 7, 295 (1940)

Great loss of fat in feces occurred.

449. LIPODYSTROPHY: REPORT OF A CASE WITH METABOLIC STUDY

J. S. Harris and R. Reiser. Am. J. Dis. Child. 59, 143 (1940). C. A. 5926 (1940)

Progressive lipodystrophy appears to be characterized by a general fault in the metabolism in addition to local changes which may be present in the tissues affected. A 9-year-old patient showed normal absorption of fat, abnormal creatinuria, a lowered dextrose tolerance, and abnormal increase in serum fats after a fat meal and deficient oxidation of fats, as compared with normal children.

450. DESCRIPTION OF A PECULIAR DISTURBANCE IN FAT ABSORPTION WITH ITS CLINICAL PICTURE

F. Heni. Klin. Wochschr. 19, 56 (1940)

451. THE DIAGNOSIS AND TREATMENT OF ACHYLIA PANCREATICA

J. M. Beazell, C. R. Schmidt and A. C. Ivy. J. Am. Med. Assn. 116, 2735 (1941)

Pancreatic ferments were absent from the duodenum. Excesses of fat and nitrogen were excreted. Fat and nitrogen were absorbed to a much greater extent after substitution (enzyme) therapy.

452. THE RESORPTION OF VITAMINS AND FATS IN PATIENTS WITH ACHLORHYDRIA

C. L. C. van Nieuwenhuizen. Nederl. Tijdschr. Geneeskunde 85, 176 (1941). C. A. 4460 (1941)

453. DISTURBANCES IN ABSORPTION OF CARBOHYDRATES, FATS AND VITAMINS IN HYPOPHYSEAL INSUFFICIENCY

C. L. C. van Nieuwenhuizen. *Acta Med. Scand.* 108, 195 (1941). C. A. 8077 (1941)

A severe disturbance of fat absorption occurred in an acromegalic patient. Desoxycorticosterone improved the absorption. A similar condition was observed in a patient with diabetes insipidus and with Cushing's syndrome.

It is assumed that an adrenal insufficiency is at least partly responsible.

454. NOTES CONCERNING THE CAUSE AND TREATMENT OF COELIAC DISEASE

C. D. May, J. F. McCreary and K. D. Blackfan. *J. Pediatrics* 21, 289 (1942)

The defect in intestinal absorption of fat and carbohydrate is shown to lie within the intestinal mucosa. The absorption of fat is favorably influenced by liver extracts and the vitamin B complex.

455. DIFFERENTIAL DIAGNOSIS OF DISTURBANCES OF FAT UTILIZATION IN SPRUE AND OTHER INTESTINAL DISEASES

W. Heupke. *Med. Klin.* 1, 378 (1940). C. A. 6627 (1942)

The characteristics of fatty stools are given for the following diseases: Sprue, pancreatic insufficiency, gastrocolonic fistula, Basedow's disease, bile exclusion, and tuberculosis of the mesenteric glands.

456. THE ASSIMILATION OF FOOD IN NON-TROPICAL SPRUE

M. Burger and A. Heinrich. *Deut. Z. Verdauungs u. Stoffwechsel Krankh.* 6, 153 (1942). C. A. 4289 (1944)

The essential disturbance in non-tropical sprue was found to be in fat absorption.

457. FAT ABSORPTION IN COELIAC DISEASE

S. Pedvis. *McGill Med. J.* 12, 249 (1943)

A discussion of the different causes of the disease and their therapy, with particular reference to fat absorption, is given. The impairment of absorption may be due to lack of phosphorylation.

458. SPRUE

H. S. Stannus. *Trans. Roy. Soc. Trop. Med. Hyg.* 36, 123 (1942). C. A. 4475 (1943)

The primary failure in sprue is attributed to lack of phosphorylation, which according to the partition theory, is essential to the absorption of fatty acids but not of neutral fat.

459. FAT AND VITAMIN A ABSORPTION IN SPRUE AND JEJUNOILEITIS

D. Adlersberg and H. Sobotka. *Gastroenterology* 1, 357 (1943)

The fat tolerance test and vitamin A tolerance test were used to show the absence of fat absorption in conditions of active sprue.

460. METABOLIC STUDIES IN PATIENTS WITH GASTROINTESTINAL CANCER. FAT METABOLISM, A METHOD OF STUDY

P. E. Rekérs, J. C. Abels and C. P. Rhoads. *J. Clin. Inv.* 22, 243 (1943)

Abnormal fat absorption was found only in a gastrectomized patient and in a patient with atrophic gastritis.

Patients with gastric carcinoma and hepatic cirrhosis showed normal absorption of fat.

461. STUDY OF THE SERUM LIPIDS IN THE COELIAC SYNDROME

L. Luzzatti and A. E. Hansen. *J. Pediatrics* 24, 417 (1944)

Ten children were studied. In five instances no increase in serum lipids occurred after the ingestion of fat; in two instances the increase was normal. Highly unsaturated fats were not absorbed any better in two cases. The explanation of the deficient fat absorption seems difficult.

462. FAT ABSORPTION IN TROPICAL SPRUE

D. A. K. Black, L. P. R. Fourman and P. Trinder. *The Lancet* 250, 574 (1946)

A balance study was made, and the results show that in moderately severe sprue 60-80% of the ingested fat is absorbed. Constancy of the percentage fat absorption with different fat intakes is explained by theories based on the failure of an enzyme system concerned in phosphorylation.

(See also Nos. 298, 301, 302, 303, 309, 313, 320, 322, 329, 338, 380, 392, 483, 487, 490, 491, 494, 496, 497, 499, 501, 502, 504, 504A, 506A, 507A, 509 and 509A.)

XVI. LIPIDS IN FECES (463-482)

463. THE ORIGIN AND DESTINY OF CHOLESTEROL IN THE ANIMAL ORGANISM. THE EXCRETION OF CHOLESTEROL BY THE DOG

Charles Doree. *Proc. Roy. Soc. B* 80, 227 (1908)

It is shown that in the dog not all cholesterol of the bile is excreted. The cholesterol that was found in feces might have come from the food. The effect of different diets was studied.

464. FAT EXCRETION

E. Hill and W. R. Bloor. *J. Biol. Chem.* 53, 171 (1922)

When moderate amounts of fat are fed the fat of the feces is largely independent of the diet, and in composition approaches that from a fat-free diet.

The fecal fat cannot ordinarily be regarded as unabsorbed food fat and, therefore, feeding experiments as a test of the extent of utilization of food fat are of doubtful value unless account be taken of the amount and kind of fat which appears in the feces independently of the food.

465. FAT EXCRETION

W. M. Sperry and W. R. Bloor. *J. Biol. Chem.* 60, 261 (1924)

Fecal fat in cats and dogs does not arise directly from unabsorbed fatty material, even though the composition of the diet influences the composition (melting point) of the fecal fat. There is found a similarity between fecal fat and blood fat.

466. LIPID EXCRETION. FURTHER STUDIES OF THE QUANTITATIVE RELATIONS OF THE FECAL LIPIDS

Warren M. Sperry. *J. Biol. Chem.* 68, 357 (1926)

Volatile, liquid and solid fatty acids are separated. The origin of the secreted lipids in the intestine of the dog is discussed. Dogs on a lipid-free diet keep on secreting lipid in the intestine. The secretion contains both free fatty acid and neutral fat.

467. LIPID EXCRETION. A STUDY OF THE RELATIONSHIP OF THE BILE TO THE FECAL LIPIDS WITH SPECIAL REFERENCE TO CERTAIN PROBLEMS OF STEROL METABOLISM

Warren M. Sperry. *J. Biol. Chem.* 71, 351 (1927)

Dogs, in which bile has been excluded from the intestine, have been maintained on strictly lipid-free diets for periods of time up to 5 weeks in length. Under these conditions they excrete lipids in amounts ranging from 1.5 to 4.5 times the average excretion while normal.

Because of the close similarity in composition of the excretions of normal dogs and dogs with bile fistula, the conclusion is drawn that the bile is not the source of fecal lipids. Various applications of the results to problems of cholesterol metabolism are discussed.

A review of previous work on cholesterol metabolism is presented.

468. LIPID EXCRETION. A STUDY OF THE PARTITION OF THE FECAL LIPIDS WITH SPECIAL REFERENCE TO BACTERIA

Warren M. Sperry. J. Biol. Chem. 81, 299 (1929)

Bile does not contribute to the fat excretion in dogs, since, in the absence of bile, fecal fat increases. About 40% of the fat in feces follows the bacteria, the rest follows non-bacterial solids, and a negligible amount is found in solution or suspension. It cannot be stated whether the fecal fat "belongs" to the bacteria and other solids or is merely an intestinal secretion absorbed into them.

469. FAT EXCRETION. EXCRETION BY THIRY-VELLA FISTULAS

Robert W. Angevine. J. Biol. Chem. 82, 559 (1929)

Various theories on the source of fecal fat are reviewed. High and low fistulas were made in dogs. The amount excreted was found to be the same for both loops and independent of the diet.

470. LIPID EXCRETION. THE PARTITION OF FECAL LIPIDS IN BILE FISTULA DOGS

W. M. Sperry. J. Biol. Chem. 85, 455 (1930)

The results are in accord with previous data in showing from 2 to 3 times as great a lipid excretion by bile fistula dogs as by normals. One dog continued to excrete lipids at a high level for 6 weeks.

When lard was fed to bile fistula dogs along with the lipid-free diet, a considerable amount escaped absorption and this was found almost entirely in the non-bacterial fraction. None was in suspension, and the probability is demonstrated, therefore, that any lipids secreted into the intestine would be absorbed in the same manner.

471. LIPID EXCRETION. THE LIPID CONTENT OF THE INTESTINAL MUCOSA

Warren M. Sperry. J. Biol. Chem. 96, 759 (1932)

From a comparison of the lipid content of the mucosa and the amounts of lipids excreted by dogs on a lipid-free diet, it is concluded that desquamation of intestinal epithelium in all probability is not an important source of the endogenous lipid excretion.

The colon mucosa contained a smaller amount of fatty acids than the small intestine mucosa. A tendency toward a smaller content of fatty acids was found in the mucosa of dogs which had ileostomies than in the mucosa of normal dogs. It is suggested that these findings may be related to the metabolic activity of the mucosa.

472. LIPID EXCRETION. THE SECRETION OF LIPIDS INTO THE INTESTINE

Warren M. Sperry and Robert W. Angevine. J. Biol. Chem. 96, 769 (1932)

It is shown that the secretion of fat occurs mainly in the small intestine of dogs. Bacterial synthesis as a source of fecal fat is ruled out because these bacteria contain no sterols when grown in vitro, whereas the fed fat does.

473. THE EFFECT OF EPINEPHRINE ON LIPID EXCRETION

E. Hill and A. Koehler. *J. Biol. Chem.* 98, 185 (1932)

On a low-fat diet it was found that the administration of epinephrine in subglycosuric amounts usually caused a definite rise in the fecal lipid excretion. Rats were used.

474. FECAL FAT AND ITS RELATION TO FAT IN THE DIET

A. Krakower. *Am. J. Physiol.* 107, 49 (1934)

Experiments were performed on human subjects. The excreted lipids were uniform in composition (iodine number) when fats differing in iodine number from 8.2 to 125.8 were fed. The amounts of dietary and fecal fat were only related to a slight extent. Fecal lipids therefore do not represent residual fat of the diet but may be in part excretions into the gastrointestinal tract.

475. EXCRETION OF FAT IN EXPERIMENTAL LIPEMIA

J. Hoshi. *Trans. Soc. Path. (Jap.)* 24, 37 (1934)

476. THE ORIGIN OF FECAL FAT IN THE ABSENCE OF BILE, STUDIED WITH DEUTERIUM AS AN INDICATOR

Arthur Shapiro, Harry Koster, D. Rittenberg and R. Schoenheimer. *J. Physiol.* 117, 525 (1936)

Human patients with bile fistula were studied. Bile could flow into the intestine or the outside at will. The absence of bile increased the fat in feces to the same amount as the intake; however, only 35% of it contained deuterium. The increase in fecal fat was due therefore to increased secretion into the lumen of the intestine.

477. CONTRIBUTIONS TO THE PHYSIOLOGY OF DIGESTION. THE INFLUENCE OF CALCIUM SALTS ON FAT DIGESTION

Y. Nakamura. *Z. Exp. Med.* 99, 494 (1936)

Calcium lactate fed to dogs increases the excretion of calcium, fatty acids, and fat.

478. EXCRETION FROM INTESTINAL EPITHELIUM

M. Kamano. *Trans. Soc. Path. (Jap.)* 29, 303 (1939)

479. FAT EXCRETION AND THE FECAL LIPID DISTRIBUTION OF AVERAGE HEALTHY CHILDREN

H. H. Williams, M. L. Shepherd and E. N. Endicott. *J. Biol. Chem.* 128, cxi (1939)

The coefficients of apparent digestibility of food fat averaged over 97% during a period in which the intake was increased from 57 to 100 gm. daily.

480. EXPERIMENTAL STUDIES ON FAT EXCRETION THROUGH INTESTINES FOLLOWING LIGATION OF BILE DUCT

M. Kamano. Trans. Soc. Path. (Jap.) 30, 181 (1940)

481. FECAL RESIDUE OF FAT, PROTEIN AND CARBOHYDRATE IN THE NORMAL DOG

R. J. Coffey, F. C. Mann and J. L. Bollman. Am. J. Dig. Dis. 7, 141 (1940)

<u>Diet</u>	<u>Per cent fat excreted</u>
Standard	2.11
High fat	3.59
High carbohydrate	2.97
High protein	3.99

Most of the excreted fat was in the form of fatty acids.

482. FAT EXCRETION BY NORMAL CHILDREN

H. H. Williams, E. N. Endicott, M. L. Shepherd, H. Galbraith and I. G. Macy. J. Nutr. 25, 379 (1943)

Nineteen healthy children were investigated.

Fat intake varied between 62 and 113 gm. per day and utilization varied from 96 to 98%.

The higher fat intake increased the excretion of soaps but did not affect the other constituents appreciably.

(See also Nos. 65, 73, 77 32, 123, 129, 139, 149, 204, 311, 316, 340, 374, 386, 431, 442, 446, 455 and 577.)

XVII. ALIMENTARY HYPERLIPEMIA (483-548)

A. Human Subjects

B. Dogs

C. Rabbits

D. Other Animals

(See also Nos. 305 and 475.)

A. Human Subjects

483. ON ULTRAMICROSCOPIC INVESTIGATION OF BLOOD DURING FAT ABSORPTION IN HEALTHY AND DISEASED PEOPLE

A. Neuman. *Wien. Klin. Wochschr.* 20, 851 (1907)

484. INVESTIGATIONS ON LIPID CHEMISTRY OF BLOOD IN PREGNANCY, AMENORRHOEA AND ECLAMPSIA. ALSO A CONTRIBUTION TO ALIMENTARY LIPEMIA AND LIPEMIA IN PREGNANCY

W. Lindemann. *Z. Geburtsh u. Gynakol.* 74, 819 (1913)

The cholesterol ester of whole blood increases during fat absorption just like the other lipids and free cholesterol.

485. THE ESTIMATION OF LIPOID AND ACID-SOLUBLE PHOSPHORUS IN SMALL AMOUNTS OF SERUM

I. Greenwald. *J. Biol. Chem.* 21, 29 (1915)

Milky sera appearing during fat absorption in human subjects were not found to contain a higher concentration of lipoid phosphorus.

486. FURTHER INVESTIGATIONS ABOUT ALIMENTARY LIPEMIA

J. Cohn and W. Heimann. *Z. Exp. Path.* 18, 213 (1916)

After butter and cream administration to human subject fat in serum is increased but cholesterol and phospholipid content is found unchanged.

487. STUDIES ON ALIMENTARY LIPEMIA IN MAN

N. I. Nissen. Monograph (1917)

A critical discussion of the validity of the data on fat absorption, with reference to the analytical methods employed, is given.

Own work on alimentary lipemia in man after the ingestion of fat, and fat and carbohydrate is presented. Abnormal changes in the alimentary lipemia curves are discussed.

488. FAT DIGESTION, ABSORPTION AND ASSIMILATION IN MAN AND ANIMALS AS DETERMINED BY THE DARK-FIELD MICROSCOPE, AND A FAT SOLUBLE DYE

Simon Henry Gage and Pierre Augustine Fish. *Am. J. Anat.* 34, 1 (1924)

An historical sketch of the work on fat absorption, with special reference to the occurrence of chylomicrons in the blood, since 1622 is given.

Typical chylomicron curves show a sharp rise and decline, the rise in man starting after 1 hour, the maximum occurring in 3-4 hours. Mineral oil and castor oil do not give rise to variation in blood chylomicron concentration. The chylomicron concentration shortly after absorption of fat has started shows a drop when the subject is under mental strain (mental activity) which is said to mean a cessation of absorption of fat.

Ether depresses the chylomicron curves in the dog.

Sudan III and scarlet red were used to stain the fat and follow its deposition in different tissues.

489. BLOOD SUGAR AND BLOOD FAT CHEMICAL STUDY

W. Arnoldi and I. A. Collazo. Z. Exp. Med. 40, 323 (1924)

After administration of sugar to human subjects, blood fat is found to be decreased. After fat administration blood fat is increased, whereas protein is found to decrease blood fat again.

Deviations in several diseases from the above rules are discussed.

490. FAT METABOLISM IN NEPHRITIS

A. Hiller, D. D. Van Slyke, G. C. Linder and C. Lundsgaard. J. Exp. Med. 39, 931 (1924)

After fat ingestion a greater increase of fatty acids and lecithin was noted in the plasma of nephritics with initially high blood lipoids than in the plasma of normal subjects or of nephritics without constant lipemia. No differences in cholesterol were found.

The accumulation of fat in their blood may be due to a disturbance in the mechanism for transferring lipoids from the blood to the tissue depots.

491. ON THE BEHAVIOUR OF BLOOD LIPIDS AFTER FAT ADMINISTRATION TO DIABETICS WITH AND WITHOUT INSULIN

H. U. Hartmann. Biochem. Z. 146, 307 (1924)

The lipemia curve is found unchanged by administration of insulin.

492. ALIMENTARY LECITHINEMIA

C. M. Leitece. Zhurnal Exp. Biol. i. Med. 6, 206 (1927)

493. THE INFLUENCE ON BLOOD LIPIDS OF SINGLE FOODSTUFFS

C. W. McClure and M. E. Huntsinger. J. Biol. Chem. 76, 1 (1928)

The gross changes demonstrated in the lipids of the blood in human subjects are generally comparable regardless of the character of the foodstuffs ingested. These changes are interpreted as the result of mobilization of lipids from the body tissues.

Increased total fatty acid concentration in the blood which follows the absorption of oleic acid is not solely the result of accumulation of that substance.

The presence in the blood of different forms of cholesterol, possibly tautomeric, of varying degrees of unsaturation is suggested by the results obtained.

494. TESTING THE ABSORPTION OF FAT BY THE PRODUCTION OF ALIMENTARY LIPEMIA

H. Strauss. Klin. Wochschr. 8, 2047 (1929)

Lipemia was studied in patients.

495. ON THE TRANSPORT OF LIPIDS BY BLOOD AFTER THE INGESTION OF OIL

I. H. Page, L. Pasternack, and M. L. Burt. *Biochem. Z.* 223, 445 (1930)

After feeding olive oil to men total fatty acids and cholesterol in blood increase, whereas phospholipids often increase but sometimes decrease.

496. ON ALIMENTARY LIPEMIA

A. Hirsch. *Klin. Wochschr.* 9, 2063 (1930)

Alimentary lipemia was not observed in people with congestion of the portal vein, cirrhosis, ascitis, etc. Also bile obstruction interferes with the production of lipemia.

497. ALIMENTARY HYPERLIPEMIA

B. Hejda. *Am. J. Med. Sci.* 180, 84 (1930)

In a normal individual hyperlipemia appears between the second and third hour after the ingestion of fat and reaches its maximum between the fourth and fifth hours, returning to its original value during the sixth hour.

In the series here reported, in cases of gastroparesis with atony, asthenia of the pancreas, mechanical icterus, and carcinoma of the stomach involving the pancreas, the lipemia either did not change during the first six hours or else there was a slow rise of the lipemia level during the period in which normally lipemia is decreasing.

In diabetes the lipemia rose earlier, reached a higher level, and even after six hours still had a tendency to rise. The lipemia curve in diabetes appears to be quite analogous to the glycemic curve. This analogy demonstrates the relation between the fat metabolism and the carbohydrate metabolism. In obesity and in adiposogenitalis and dystrophy, and myelogenous leukemia, the leukemic curve is analogous to the pre-diabetic curve.

497A. PLASMA FATS IN SOME CASES OF MENTAL DEPRESSION

E. M. Hill, C. N. H. Long and D. Slight. *J. Biol. Chem.* 92, lxxx1 (1931)

Alimentary hyperlipemia was studied in patients. Total fatty acids were found higher in certain cases of mental depression.

498. THE EFFECT OF THE INGESTION OF A LARGE AMOUNT OF FAT AND OF A BALANCED MEAL ON THE BLOOD LIPIDS OF NORMAL MAN

E. B. Man and E. F. Gildea. *J. Biol. Chem.* 99, 61 (1932)

The ingestion of 3.5 to 4 gm. of fat per kilo of body weight by nine normal men and women is shown to produce a marked rise in serum fatty acids and a moderate increase in the serum phospholipids.

The ingestion of a balanced meal, containing at least 0.6 gm. of fat per kilo and with carbohydrate plus protein slightly exceeding the weight of the fat, is found to produce a rise in the serum fatty acids of normal men and women.

499. VARIATIONS IN THE TOTAL BLOOD LIPID IN ALIMENTARY LIPEMIA

H. F. Wechsler. Arch. Int. Med. 50, 37 (1932)

1) The total blood lipid curves after the ingestion of 100 cc. of olive oil in sixty-seven subjects who were apparently free from pancreatic or hepatic disease are presented.

2) The curves could be subdivided into three categories: ascending, 63.2 per cent; flat, 17.5 per cent; and descending, 19.3 per cent.

3) The age of the subject and the presence of arteriosclerosis markedly influenced the total blood lipid. Persons in the second and third decades presented a flat curve, those in the fourth, fifth and sixth decades an ascending curve and those showing evidence of arteriosclerosis a flat or descending curve.

4) Starvation produced a moderate progressive rise in the total blood lipid.

5) Dextrose eliminated the starvation effect.

500. ALIMENTARY HYPERLIPEMIA IN HUMAN SUBJECTS AND ITS RELATION TO BLOOD LIPASE

M. Werner. Z. Exp. Med. 83, 402 (1932)

Blood lipase was found to remain constant during alimentary hyperlipemia.

501. A STUDY OF FAT TOLERANCE TESTS

H. Blotner and R. Fitz. J. Clin. Inv. 13, 707 (1934)

After 500 cc. of a test meal containing 20% fat was administered to patients orally, the blood fat in normal individuals remained constant, whereas in the obese person or in a person with diabetes insipidus a progressive rise in blood cholesterol concentration was noticed. The rise was inhibited with posterior lobe pituitary extract.

502. THE BLOOD LIPIDS IN THE POSTABSORPTIVE STATE AND AFTER THE INGESTION OF FAT IN NORMAL HUMAN SUBJECTS AND IN A CASE OF DISSEMINATED CUTANEOUS XANTHOMATA

I. L. Chaikoff, T. H. McGavack and A. Kaplan. J. Clin. Inv. 13, 1 (1934)

Marked variations in the response of blood fat to the ingestion of 100 cc. olive oil were found in different normal persons. No abnormality in this response was found in individuals with Xanthomatons. The use of the lipemia curve as an index of fat metabolism is discussed.

503. CHANGES OF TOTAL LIPID AND IODINE NUMBER OF BLOOD FAT IN ALIMENTARY LIPEMIA

W. Wilson and J. Hanner. J. Biol. Chem. 106, 323 (1934)

Cream and cod liver oil were fed to children, and the iodine number of the extra fat in serum was found to be higher after feeding the unsaturated fat. This is taken to mean that most of the extra fat in the blood originates from ingested fat.

504. THE EFFECT OF ADRENALIN ON THE ALIMENTARY LIPEMIA OF DIABETICS

M. Sullivan and P. Cameron. *Am. J. Med. Sci.* 187, 457 (1934)

The administration of adrenalin in dosage sufficient to produce physiologic response causes a lowering of the increasing blood fats in the alimentary lipemia of diabetes mellitus.

This fact is significant as additional evidence supportive of the view that adrenalin has a direct regulatory effect on fat metabolism.

504A. STUDIES OF BLOOD FAT IN RELATION TO THE PATHOGENESIS OF OBESITY (Lipoitrin-Resistance)

W. Raab. *Wien. Klin. Wochschr.* 47, 1284 (1934). C. A. 1162 (1935)

Lipoitrin prevents blood fat from increasing in normal people during a fat tolerance test, but does not prevent such an increase in obese persons.

505. ALIMENTARY HYPERLIPEMIA

K. Tajima. *Biochem. Z.* 276, 343 (1935)

In humans the concentration of neutral fat, phospholipids, and cholesterol ester increases markedly after feeding olive oil. In rabbits hyperlipemia also occurs but the cholesterol fraction is not found to increase.

506. ALIMENTARY LIPEMIA

R. Indovina and G. Graziano. *Biochem. e. Trap. Sper.* 23, 374 (1936). C. A. 31; 1859 (1937)

An immediate increase of unsaturated acids appears in the blood of normal persons after ingestion of 100 g. butter. The maximum is reached during the second hour and returns to normal during the third hour.

506A. THE ADMINISTRATION OF FATS AND SERUM LIPOIDS IN ECZEMA AND SEBORRHEIC DERMATITIS OF INFANTS

E. Freudenberg and L. Schornstein. *Z. Kinderheilk* 57, 675 (1936). C. A. 4918 (1936)

Alimentary hyperlipemia was found to be similar in the healthy and sick infants.

507. ULTRAMICROSCOPIC PARTICLES IN NORMAL HUMAN BLOOD

A. C. Frazer and H. C. Stewart. *J. Physiol.* 90, 18 (1937)

The particle counts in serum are increased by the ingestion of fatty food. The particle counts in serum are maintained at a constant basic level in starvation. The particle count rises after a meal, the time curve having two components. The initial rise is essentially due to gut movements and previously ingested fat; the delayed rise is due to actual fat absorbed. The lipemia following a meal containing fat occurs within 1-1/4 hours of ingestion and reaches a maximum in 2-3 hours, and the curve returns to the resting level in 4-1/2 hours. The particles studied consist almost entirely of fat. Blood-fat estimations give curves coinciding with simultaneous particle curves.

The curves depicting the similarity between chylomicron count and chemically determined fat are deceiving. The only similarity is the position of the maximum. If the data are expressed as per cent increase the chylomicron count increases many times the per cent fat.

507A. THE BLOOD KETONE CURVE AFTER A FAT TOLERANCE TEST

S. S. Kauvar. *Am. J. Med. Sci.* 193, 617 (1937)

A fat tolerance curve is described with the level of blood ketones as the indicator. Measurements are made on control cases and a series of endocrinopathics. The interpretation of the results is discussed.

508. THE INTERPRETATION OF THE NORMAL CHYLOMICROGRAPH

A. C. Frazer and H. C. Stewart. *J. Physiol.* 95, 23P (1939)

- 1) Preliminary rise of chylomicrograph is due to fatty residual of the previous meal.
- 2) Displacement of the curve is caused by delayed emptying of the stomach.
- 3) A fat person shows a higher curve than a thin one. Addition of pancreatic lipase also decreases the height of a curve. Both phenomena are explained by change in the extent of digestion of the fats.
- 4) A marked difference is found between capillary and venous blood.

509. ALIMENTARY LIPEMIA IN YOUNG DIABETICS WITH EVIDENCE OF LIVER DAMAGE OR DYSFUNCTION

R. C. Lowe. *J. Lab. and Clin. Med.* 24, 943 (1939)

The alimentary lipemia was studied in a group of 10 young diabetics, all of whom gave evidence of liver dysfunction or anatomic liver damage. No correlation was found between the level or duration of elevation of the total blood lipids and the degree of liver damage indicated by several liver function tests.

509A. STUDIES ON THE FAT LOADING OF DIABETICS

T. Hatakeyama, K. Takahasi, Y. Tutumi and K. Yamazaki. *Biochem. Z.* 300, 392 (1939)

Butter was given to normal and diabetic persons and lipemia was studied. In diabetics the hyperlipemia reached a higher level and was of longer duration.

510. CHOLINE AND COLAMINE PHOSPHOLIPIDS OF BLOOD SERUM DURING ALIMENTARY LIPEMIA

G. Brante. *Biochem. Z.* 305, 136 (1940)

Cephalin increases as much as the choline containing phospholipids during alimentary lipemia in human subjects.

511. INVESTIGATIONS OF THE DAILY RHYTHMS IN THE PRODUCTION OF CHYLOMICRONS IN MAN ON THE SUPPLY OF FAT

E. Bohm, B. Gernandt and H. Holmbren. *Acta Med. Scand.* 106, 579 (1941). C. A. 4439 (1941)

In normal young people receiving 10 g. fat every other hour the number of chylomicrons was greater during the night than during the day, the median values being 12.5 ± 1.40 and 8.2 ± 0.92 , respectively.

512. THE AMOUNT OF FAT IN THE BLOOD AFTER A MEAL AS ESTIMATED BY COUNTING THE CHYLOMICRONS

R. R. Cooper and H. Lusk. *Am. J. Dig. Dis.* 9, 395 (1942)

Several normal individuals and patients were studied by the method of Elkes, Frazer, Stewart. Results similar to those of these authors were obtained.

513. INFLUENCE OF LECITHIN FEEDING ON FAT AND VITAMIN A ABSORPTION IN MAN

D. Adlersberg and H. Sobotka. *J. Nutr.* 25, 255 (1943)

Fat absorption was measured by fat tolerance test; e.g., total serum lipids before and after ingestion of 1 gm. of butterfat per kg. body weight.

Lecithin added to the ingested fat enhances the elevation of total lipids in serum, which is probably due to increased absorption or to lesser extent to mobilization of hepatic deposits.

Note: Lecithin alone did not give rise to increased lipid levels.

514. COMPARATIVE INVESTIGATIONS ON THE BEHAVIOUR OF ALIMENTARY LIPEMIA, CHOLESTEROL AND BLOOD SUGAR LEVELS AFTER FEEDING ONE SYNTHETIC AND TWO NATURAL FATS

G. Kabelitz. *Arch. Physiol. Pflug.* 247, 593 (1944)

In man lipemia up to 30% above the fasting level was found after feeding the synthetic fat (cholesterol free), sesame oil and rape oil. Also cholesteremia occurred to nearly equal extent. The synthetic fat gave a greater rise in blood sugar than the other two fats.

(See also Nos. 151, 159A, 187, 282, 285, 298, 302, 306, 320, 432, 433, 436, 437, 438, 440, 444, 549 and 555).

B. Dogs

515. ON THE FAT CONTENT OF DOG BLOOD UNDER DIFFERENT EXPERIMENTAL CONDITIONS

L. Lattes. Arch. Exp. Path. u. Pharm. 66, 132 (1911)

The blood fat is found to be doubled after the ingestion of a meal rich in fat.

516. VARIATIONS OF LIPEMIA AND CHOLESTEREMIA DURING STARVATION AND AFTER FEEDING

E. F. Terroine. J. de Physiol. et de Path. Gen. 16, 285 (1914)

After feeding a meal rich in fat and low in cholesterol to dogs, an increase in blood fat and blood cholesterol of 30% is observed.

517. VARIATIONS IN THE FAT CONTENT OF THE BLOOD UNDER APPROXIMATELY NORMAL CONDITIONS

W. R. Bloor. J. Biol. Chem. 19, 1 (1914)

Feeding fat to dogs caused an increase in fat content of blood. With the thoracic duct tied there was no increase. Intravenously injected fat disappeared from the blood in less than five minutes.

Fasting may or may not produce an increase in the blood fat, depending upon the nutritional state of the animal.

Ether anesthesia produced a rise in blood fat in the fasted dog. When the dog had been fed, the blood fat decreased first and increased again afterwards.

This shows that ether stops fat absorption.

518. STUDIES ON BLOOD FAT

W. R. Bloor. J. Biol. Chem. 23, 317 (1915)

Blood samples of dogs were analyzed for total fat, cholesterol, and lecithin. Cholesterol level does not change during alimentary lipemia; lecithin increases. The extent of alimentary lipemia differs in different animals and in the same animal at different times.

519. ON LIPEMIA

I. Bang. Biochem. Z. 91, 104 (1918)

After feeding fat to dogs, the neutral fat in blood (Petroleum-ether fraction) was found to increase; the alcohol fraction usually remained without change.

520. ON LIPEMIA

I. Bang. Biochem. Z. 91, 111 (1918)

The feeding of lard does not produce hyperlipemia in dogs. Butter often produces hyperlipemia, and olive oil always does.

Dogs fed butter are found to produce an intense hyperlipemia the first time they

are fed fat, but when repeated again and again the hyperlipemia finally disappears.

Carbohydrate feeding with fat is found to inhibit hyperlipemia. It is found that neutral fat or fatty acids plus glycerol produce hyperlipemia, whereas fatty acids fed alone do not.

It is concluded that fatty acids and neutral fat are absorbed by way of the portal vein and that only a small amount of fat is transported by way of the lymph.

521. THE RELATION BETWEEN THE CHYLOMICRONS AND THE LIPOID CONTENT OF THE BLOOD

A. Knudson and W. K. Grigg. *Proc. Soc. Exp. Biol. and Med.* 20, 462 (1923)

There is no constant relation between the total fatty acids and the chylomicrons in the blood of dogs after feeding fat and glycerin and in the hemorrhagic lipemia of rabbits

522. STUDIES ON LIPID METABOLISM AND ALIMENTARY LIPEMIA

S. Leites. *Biochem. Z.* 184, 273 (1927)

Large doses of orally administered olive oil produce an increase in blood fat and cholesterol in the dog. Smaller doses of olive oil produce a phase of hypolipemia before a hyperlipemia occurs. The cholesterol level of blood in this case varies inversely to that of the neutral fat fraction.

523. STUDIES ON LIPID METABOLISM AND ALIMENTARY LECITHINEMIA

S. Leites. *Biochem. Z.* 184, 310 (1927)

In dogs fed lecithin the increase in blood lipid phosphorus is no greater than the one obtained after fat feeding; also the neutral fat and cholesterol in blood are increased.

524. THE INFLUENCE OF DIFFERENT FOODS ON THE AMOUNT OF FOURFOLD UNSATURATED ACIDS IN THE BLOOD

N. Berend. *Biochem. Z.* 229, 323 (1930)

After feeding fat to dogs the blood level of the fourfold unsaturated acids is increased after a preliminary decrease. This strengthens the view that the highly unsaturated acids play a part in the fat transport.

(The methods are described by H. Tangl. *Biochem. Z.* 226, 180 (1930))

525. STUDIES ON FAT METABOLISM

H. R. Rony and T. T. Ching. *Endocrinology* 14, 355 (1930)

It was shown experimentally in dogs that fasting augments and previous abundant feeding decreases alimentary lipemia. The administration of glucose either by mouth or parenterally inhibited alimentary lipemia in fasting dogs. Insulin was found to inhibit alimentary lipemia.

It was concluded that carbohydrate metabolism plays an important, if not essential, role in the regulation of the blood fat level of normal dogs during the alimentary absorption of fat. Alimentary lipemia curves were taken as an approximate measure of fat

utilization.

526. CHYLOMICRON CONTENT AND TOTAL LIPIDS OF BLOOD PLASMA AS DETERMINED ON DOGS

E. H. McArthur. *Proc. Soc. Exp. Biol. and Med.* 28, 555 (1931)

Good correlation was not found between chylomicron count and chemical analysis of total lipids.

527. BLOOD-PHOSPHORUS IN FAT ABSORPTION

B. Vahlquist. *Biochem. J.* 25, 1628 (1931)

In experiments on dogs the phosphatides of plasma showed a regular increase after fat ingestion, whereas the phosphatides of the corpuscles remained practically unchanged.

The non-lipoid P of plasma showed a small increase during fat absorption, the non-lipoid P of the corpuscles being unaltered. The results argue against the assumption that the fat absorbed from the intestine is transformed into phosphatides of the red corpuscles of the blood.

528. DIET AND THE BLOOD LIPIDS

W. R. Bloor. *J. Biol. Chem.* 103, 699 (1933)

Under fairly constant conditions of diet and environment, the level of the plasma lipids in the postabsorptive state in dogs is found to be satisfactorily constant over periods up to 2 years.

In dogs single overfeedings with fat or carbohydrate to the extent of half the ordinary caloric intake generally result in postabsorptive state, while the cholesterol level is not affected. The high values are temporary, lasting generally not more than 2 or 3 days. Similar overfeedings with protein and single underfeedings have no effect.

529. ALIMENTARY LIPEMIA AFTER ADMINISTRATION OF FATS TO SPLENECTOMIZED ANIMALS

S. Marino. *Arch. Farmacol. Sper.* 55, 289 (1933). C. A. 5386 (1933)

In splenectomized dogs alimentary lipemia is more marked and of longer duration than in normal animals.

529A. SERUM LIPID CHANGES IN RELATION TO THE INTERMEDIARY METABOLISM OF FAT

A. E. Hansen, W. R. Wilson and H. H. Williams. *J. Biol. Chem.* 114, 209 (1936)

Linseed and coconut oil were fed to dogs in various nutritional states and the lipid fractions during alimentary hyperlipemia were determined. Iodine numbers of fats were determined.

530. LECITHINAEMIA FOLLOWING THE ADMINISTRATION OF FAT

G. Hevesy and E. Lundsgaard. *Nature* 140, 275 (1937)

Olive oil and P^{32} were administered orally to a dog. The increase in plasma phospholipid P^{31} and phospholipid P^{32} is measured. The increase in plasma phospholipid P^{32} is measured as a minimal increase.

It is concluded that phospholipid during fat absorption is formed outside the intestinal tract.

530A. FAT AND LIPID METABOLISM IN ECK-FISTULA DOGS

L. Kesztyus and J. Martin. *Biochem. Z.* 289, 341 (1937)

Olive oil with or without cholesterol was fed, and alimentary hyperlipemia was studied. The normal hypolipemic phase was not found in this type of dog, which is explained by a decreased elimination of neutral fat of the plasma of the Eck-fistula dog.

531. SUSTAINED HYPERLIPEMIA OF DIETARY ORIGIN IN THE DOG

E. V. Flock, W. C. Corwin and J. L. Bollman. *Am. J. Physiol.* 123, 558 (1938)

When dogs are fed diets with 8, 36 or 73% fat to which phospholipids are added, a sustained hyperlipemia is produced. Neutral fat and cholesterol of blood increase mainly, phospholipids much less.

The hyperlipemia quickly subsides when phospholipids are omitted from the diet.

532. THE CHARACTERISTICS OF ALIMENTARY LIPEMIA IN DOGS

C. M. Leitece and A. I. Odinov. *Fiziol. Zhurnal* 25, 370 (1939)

533. THE PLASMA AND RED BLOOD CELL LIPIDS IN PERSISTENT (DIABETIC) LIPEMIA AND TRANSIENT (ALIMENTARY) LIPEMIA

S. H. Rubin. *J. Biol. Chem.* 131, 691 (1939)

It was found that after the ingestion of large doses of olive oil, dogs showed moderate increases in plasma phospholipids and triglycerides but not in free or total cholesterol. The corpuscular lipids remained unchanged.

534. MECHANISM OF ALIMENTARY HYPERLIPEMIA

G. Hetenyi. *Z. Exp. Med.* 106, 42 (1939)

Dogs and rabbits are used.

Fat that is absorbed by way of lymph is held in the lungs and then slowly released. The rate of removal of fat from the blood depends upon the fat depots and is seen to increase in obesity.

The literature on the role of the lungs, liver, spleen and kidney in fat metabolism is reviewed.

535. ABOLISHMENT OF ALIMENTARY LIPEMIA FOLLOWING INJECTION OF HEPARIN

P. F. Hahn. Science 98, 19 (1943).

It was found that heparinized whole blood, plasma or saline abolished the lipemia in dogs within five minutes. Citrated blood did not change the lipemia. No explanation is given.

(See also Nos. 153, 210, 259, 288, 299, 300, 304, 339, 546, 550, 551, 553, 554, 571 and 589.)

C. Rabbits

536. ON THE PATHOGENESIS OF LIPEMIA

S. Sakai. *Biochem. Z.* 62, 387 (1914)

In normal rabbits no marked alimentary lipemia is found. In anaemic rabbits such a lipemia is very much increased; this is explained by the decreased level of serum lipases.

537. EXPERIMENTAL LIPO-CHOLESTEREMIA

M. Verse. *Beit. z. Path. Anat.* 63, 789 (1917)

In rabbits it is found that excess of cholesterol in blood increases the total fat content of the blood and also that excess of fat increases the cholesterol.

538. STUDIES ON LIPEMIA

W. Milbradt. *Biochem. Z.* 223, 278 (1930)

An extensive discussion of the work on different lipemias is given. The role of different tissues in the storage of lipids is studied in rabbits.

539. ON AN EXPERIMENTAL HYPERLIPEMIA OF RABBITS AND ON THE CURE OF HEMORRHAGIC LIPEMIA

T. Hatakeyama. *Biochem. Z.* 285, 11 (1936)

In the starving animal neither "sucking" (ear) nor hemorrhagic lipemia occurs, but on feeding under those circumstances lipemia occurs suddenly.

The lipemia originates through a drawing-in of intestinal lymph into the blood stream.

The white turbidity of plasma is due to an increase in neutral fat.

540. ON THE ROLE OF PHOSPHOLIPIDS IN FAT METABOLISM. II.

Camillo Artom and Giuseppe Peretti. *Arch. Internat. Physiol.* 36, 351 (1933)

An emulsion of "Radiopol" (iodized fat) is given by stomach tube to rabbits. Iodized fat accumulates in whole blood up to 20 hours after ingestion. A considerable part of the lipid iodine appears in the liver and blood in non-lipid form; this makes it hard to make quantitative measurements. It is thought that the experiments are proof for the active participation of phospholipids in blood and liver in transport and intermediary metabolism.

541. THE TOTAL FATTY ACIDS OF THE LIVER AND OF THE BLOOD AFTER THE ADMINISTRATION OF VARIOUS FATS

G. Peretti and D. Tore. *Boll. Soc. Ital. Biol. Sper.* 8, 1429 (1933). C. A. 3110 (1934)

Fats were administered to rabbits.

<u>Fats administered</u>	<u>Maximum % increase</u>	
	<u>Liver fat</u>	<u>Blood fat</u>
Iodized fat	281.2	234
Margerine	72.3	181
Olive oil	46.5	127
Sesame oil	40.6	90
Poppyseed oil	27.4	102
Linseed oil	6.2	282

542. ALIMENTARY LIPEMIC CURVE IN RABBITS AFTER NEPHRECTOMY AND RESECTION OF REMAINING KIDNEY

C. Monticone. Arch. Ital. di. Med. Sper. 4, 125 (1939)

543. INDIVIDUAL PHOSPHOLIPIDS IN PLASMA OF RABBITS AFTER FATTY MEALS

C. Artom and J. A. Freeman. J. Biol. Chem. 135, 59 (1940)

Rabbits were fed a single dose of olive oil. Plasma lecithins increase; the cephalins decrease.

It is pointed out that this finding is in line with assumption that the lecithins are the only phospholipids involved in the transport of absorbed fatty acids.

544. STUDIES ON LIPEMIA

R. A. Izzo and A. Marenzi. Soc. Argent. de Biol. 19, 564 (1943)

A study was made of the plasma lipids of dogs after feeding fat or meat. The ingestion of fat did not produce significant variations in the different plasma lipids. The ingestion of meat produced greater and more significant variations in the plasma lipid content. This seems to show that a relation exists between lipid and protein metabolism.

(See also Nos. 136, 534 and 552.)

D. Other Animals

545. ON ALIMENTARY LIPEMIA

E. Neisser and H. Braeuning. *Z. Exp. Path.* 4, 747 (1907)

The relation between the turbidity of the serum and the fat absorbed in different species is discussed.

546. THE COMPARATIVE FAT CONTENT OF THE PORTAL VEIN AS DETERMINED BY THE PRESENCE OF FAT PARTICLES WITH THE DARKFIELD MICROSCOPE

P. A. Fish. *Proc. Soc. Exp. Biol. and Med.* 20, 62 (1922)

In kittens during digestion the chylomicron count of the aorta, jugular vein, and portal vein showed no difference. The liver became stained with Sudan III dissolved in the administered fat. In adult cats and dogs the count in the portal vein was markedly less than in the two other blood vessels, and the liver was not stained. It is suggested that in the latter animals the liver is less important for fat storage. It seems, however, from these experiments that in the adult animals the chylomicrons may be produced in the liver or other tissues rather than in the intestine.

547. ON THE INFLUENCE OF INSULIN ON EXPERIMENTAL LIPEMIA

A. I. Levin. *Z. Exp. Med.* 96, 532 (1935)

In cats that were fed cholesterol dissolved in plant oil the lipemia (cholesteremia) was decreased by insulin.

548. POST ALIMENTARY LIPEMIA AFTER EXTENSIVE RESECTION OF SMALL INTESTINE (AN EXPERIMENTAL STUDY)

A. Paoletti-Perini. *Arch. Ital. di Med. Sper.* 5, 177 (1939)

(See also Nos. 103, 187, 210 and 273.)

XVIII. BLOOD CELLS IN FAT ABSORPTION (549-564)

- A. Function of Red Blood Cells in Fat Absorption**
- B. Function of Leucocytes in Fat Absorption**
- C. Damage of Red Blood Cells During Fat Absorption**

A. Function of Red Blood Cells in Fat Absorption

549. ON THE MASKING OF BLOOD FATS AND ALIMENTARY LIPEMIA IN MAN

J. Muller. Z. Physiol. Chem. 86, 469 (1913)

Lipids in serum and red blood cells are determined. It is shown that the fatty acid and cholesterol contents of the red blood cells vary inversely with that of serum when lipemia is produced; so the serum lipids may have come from the red blood cells.

550. FAT ASSIMILATION

W. R. Bloor. J. Biol. Chem. 24, 447 (1916)

Total fatty acids increase in both plasma and corpuscles, but the increase is generally more marked in the corpuscles. Lecithin increases greatly in the corpuscles but only slightly in the plasma.

No definite changes in the quantity of cholesterol were noted. A fairly constant relationship between total fatty acids and lecithin was noted in whole blood and corpuscles.

These results are believed to justify the conclusions that: (a) the blood corpuscles take up the fat from the plasma and transform it into lecithin; (b) most, if not all, of the absorbed fat is so transformed; and therefore (c) lecithin is an intermediate step in the metabolism of the fats.

551. RELATIONSHIP BETWEEN CHOLESTEROL AND CHOLESTEROL ESTERS IN THE BLOOD DURING FAT ABSORPTION

Arthur Knudson. J. Biol. Chem. 32, 337 (1917)

Dogs were used. The quantity of cholesterol showed no constant change, agreeing with earlier investigations. The cholesterol esters increased in both plasma and corpuscles, but the increase was most marked in the corpuscles. The fatty acids and lecithin likewise increased in plasma and corpuscles, but the increase was greater in the corpuscles. A fairly constant relationship between total fatty acids and cholesterol esters and between lecithin and cholesterol esters was noted in the whole blood.

The greater increases of cholesterol esters and lecithin in the blood corpuscles, along with the greater amount of fatty acids, would indicate that the blood corpuscles play a very active part in fat metabolism.

552. ON THE PARTITION OF BLOOD LIPIDS DURING INCREASED FAT ABSORPTION

R. Iwatsuru. Arch. Physiol. Pflug. 214, 295 (1926)

Lipids in serum of rabbits increase after fat feeding, whereas in erythrocytes they do not change.

It is proposed that the red blood cells are not of importance in fat metabolism.

553. CHANGES IN THE COMPOSITION OF THE RED BLOOD CORPUSCLE DURING FAT ABSORPTION

M. Bodansky. Proc. Soc. Exp. Biol. and Med. 28, 628 (1930)

The work of Knudson (J. Biol. Chem. 32, 337 (1917)) has been confirmed, but it is pointed out that to compare increases in neutral fat, cholesterol ester and phosphatide

it is more advantageous to express them as moles rather than as grams. After administering 50 gm. olive oil to a dog it is found that the maximum total fatty acid of red blood cells occurs from 2 to 4 hours after administration of fat, whereas the increase in cholesterol esters and phosphatide is maximal at the 6-hour interval. As a rule, the increase of the latter fraction amounts to 20% of the total increase in fatty acids. It is also found that the increase in plasma fatty acids is about half of the increase in red blood cells.

554. DISTRIBUTION OF UNSATURATED FATTY ACIDS IN THE BLOOD DURING FAT ABSORPTION

M. Bodansky. *Proc. Soc. Exp. Biol. and Med.* 28, 630 (1930)

Olive oil was administered to dogs by stomach tube. It was found that the unsaturated fatty acid accumulated more in the red blood cells than in plasma. The increase of unsaturated fatty acids is not as great, however, as the increase in saturated fatty acids.

It is postulated that: 1) Oleic acid undergoes saturation; 2) saturated fat is mobilized from the fat depots during fat absorption.

The second possibility is thought to be the more likely one.

555. ON THE BEHAVIOUR OF PHOSPHOLIPIDS, AND CHOLESTEROL IN BLOOD AND PLASMA IN MAN AFTER FEEDING OLIVE OIL

H. Wendt. *Biochem. Z.* 250, 212 (1932)

After feeding olive oil the phospholipid and cholesterol of plasma increase, whereas the red blood cells' content does not change.

(See also Nos. 153, 159A, 527 and 533.)

B. Function of Leucocytes in Fat Absorption

556. A STUDY OF THE REACTION OF LYMPHATIC ENDOTHELIUM AND OF LEUCOCYTES IN THE TADPOLE'S TAIL, TOWARD INJECTED FAT

Eliot R. Clark and Eleanor Linton Clark. *Am. J. Anat.* 21, 421 (1917)

Olive oil, oleic acid, cream and yolk of egg were injected in the tail of frog larva.

Leucocytes respond quickly to the injected substances by migrating toward them in large numbers and actively engulfing the fat. The fat is absorbed, apparently, through the combined efforts of leucocytes and lymphatics.

The rapidity of absorption depends upon the size of the fat droplets: the fine emulsions of cream and yolk of egg are taken up very much more quickly than the single relatively large globules of olive oil and oleic acid.

The fat appears to be changed within the leucocytes and to be absorbed in a soluble form by the lymphatics.

557. THE ROLE OF LEUCOCYTES IN FAT ABSORPTION

E. H. Leach. *J. Physiol.* 93, 1 (1938)

Because no fat could be identified within lymphocytes and because in the benzene-poisoned animals there was no accumulation of fat within the epithelial cells or depletion of lymphocytes of the mucosa, it is concluded that lymphocytes do not transport fat from the epithelial cells or from the lumen of the intestine to the lacteals.

(See also No. 430.)

C. Damage of Red Blood Cells During Fat Absorption

558. THE ADAPTIVE VALUE OF ABSORPTION OF FATS INTO THE LYMPHATICS

Victor Johnson and Willard Freeman. *Am. J. Physiol.* 124, 466 (1938)

The lacteal lymph contains a hemolytic agent after fat absorption; the thoracic duct lymph contains less of same. It is suggested that this substance may be glycerol, because glycerol given intravenously has hemolytic effect, which is diminished by the simultaneous injection of Na-butyrate. The hemolysis is determined by: 1) red cell count; 2) red cell histology; 3) color of plasma.

559. THE HEMOLYTIC ACTION OF CHYLE

Willard L. Freeman and Victor Johnson. *Am. J. Physiol.* 130, 723 (1940)

The existence of a hemolytic agent in thoracic duct lymph during absorption of ingested fat is amply confirmed. Other lymph is not hemolytic.

Evidence is presented that this hemolytic agent is not cholesterol, neutral fat, bile salts, enzymes, glycerol, or due to changes in osmotic pressure, hydrogen ion concentration, or temperature.

The soap plus free fatty acid content of chyle is 3.3 to 6.3 mgm. per cubic centimeter during rapid fat absorption. Most of this is probably soap.

These quantities are sufficient to account for the hemolytic action of chyle.

The duct lymph of fasting dogs contains too little fatty acid and soap to produce hemolysis.

560. INCREASED TOTAL BILE PIGMENT OUTPUT ON A HIGH FAT DIET

W. L. Freeman, A. Loewy, A. Marchello and V. Johnson. *Fed. Proc.* 1, 25 (1942)

It is shown on dogs with bile fistula that bile pigment excretion (red blood cell destruction) is increased on a high fat diet.

561. INCREASED ERYTHROCYTE DESTRUCTION ON A HIGH FAT DIET

Arthur Loewy, Willard Freeman, Albino Marchello and Victor Johnson. *Am. J. Physiol.* 138, 230 (1943)

In five dogs with internal bile fistula the daily total bilirubin output was significantly higher on high-fat diets than on calorically equivalent low-fat diets.

This effect was also demonstrated in two dogs with external bile fistula. These findings indicate that red blood cell destruction proceeds at a faster rate on a high-fat diet than on a low-fat diet; this effect is probably caused by the introduction of a hemolytic substance into the blood stream by way of the lymphatics.

562. INCREASED RED BLOOD CELL FRAGILITY AFTER FAT INGESTION

Joan Longini and Victor Johnson. *Am. J. Physiol.* 140, 349 (1943)

The fragility of red blood cells is increased after fat absorption in dogs; probably free fatty acids and soaps are responsible for this phenomenon.

Anemia is probably prevented by the delay in fat absorption by:

- 1) Vomiting after a high fat meal.
- 2) Slower emptying of the stomach.
- 3) Absorption of fat by the lymphatics and its gradual release in blood.

563. IN VIVO HEMOLYSIS PRODUCED BY SOAP INJECTION

L. W. Freeman, A. Loewy and V. Johnson. Am. J. Physiol. 140, 556 (1944)

Calculations show that absorbed free fatty acids and soaps from the fat of a normal diet are responsible for a significant proportion of the daily red blood cell destruction in a normal human being.

The absorption of products of fat digestion into the lymphatics is thus an adaptive mechanism.

564. ERYTHROCYTE DAMAGE BY LIPEMIC SERUM IN NORMAL MAN AND IN PERNICIOUS ANEMIA

V. Johnson, J. Longini and L. W. Freeman. J. Am. Med. Assn. 124, 1250 (1944)

The erythrocytes of normal man are rendered more susceptible to hypotonic hemolysis (in a standard fragility test) by exposure to lipemic serum. This constitutes further evidence that fat ingestion is one factor in the normal daily destruction of red blood cells.

XIX. PATHWAY OF ABSORPTION (565-596)

A. Lymph

B. Portal Vein

A. Lymph

565. ON THE THEORY OF FAT ABSORPTION

P. V. Walther. Arch. f. Anat. Physiol. pg. 329 (1890)

Studies on thoracic duct lymph of dogs were made.

566. ON ABSORPTION FROM THE INTESTINE ACCORDING TO OBSERVATIONS ON A LYMPH FISTULA IN A HUMAN

I. Munk and Rosenstein. Arch. f. Anat. Physiol. pg. 376 (1890)

A patient with elephantiasis in the left leg was used. A fistula developed in the thigh.

After eating fat, 60% of the ingested dose could be recovered in 13 hours.

It is claimed that nearly all the intestinal lymph flows from the cysterne chyle downward towards the fistula. Fatty acids when fed were found in the lymph converted to neutral fat.

567. THE ABSORPTION FROM THE INTESTINE ACCORDING TO INVESTIGATIONS OF A LYMPH FISTULA IN A HUMAN

I. Munk and A. Rosenstein. Virch. Arch. f. Path. Anat. 123, 230 (1891)

The absorption of different fats and their appearance in the lymph are measured.

568. THE ABSORPTION FROM THE INTESTINE ACCORDING TO INVESTIGATIONS OF A LYMPH FISTULA IN A HUMAN

I. Munk and A. Rosenstein. Virch Arch. f. Path. Anat. 123, 484 (1891)

A continuation of the experiments described earlier is presented.

569. THE ABSORPTION OF FATTY ACIDS OF NATURAL FATS WHILE BYPASSING THE THORACIC DUCT

O. Frank. Arch. f. Anat. Physiol. pg. 497 (1892)

570. THE PRESENT STATUS OF THE THEORY OF FAT ABSORPTION AND A CONVICTION OF THE VIVISECTION ON HUMANS CONNECTED TO THIS STUDY

E. Pfluger. Arch. Physiol. Pflug. 82, 303 (1900)

The theory of fat absorption postulated by Munk and Rosenstein is sharply criticised.

The paper deals as much with personal issues as with scientific arguments.

571. ON THE ABSORPTION OF FATS AND THE CHANGING BLOOD FAT LEVEL AFTER LIGATION OF THE THORACIC DUCT

I. Munk and H. Friedenthal. Centralblatt f. Physiol. pg. 297 (1901)

In dogs after ligation of the thoracic duct the blood fat still increases up to six fold. This does not confirm the findings of O. Frank.

572. THE ABSORPTION OF THE MONOGLYCERIDES OF THE HIGHER FATTY ACIDS

A. Argyris and O. Frank. *Z. Biol.* 59, 143 (1912)

It is shown that monoglycerides are not absorbed by dogs as such but appear in the lymph as triglycerides.

573. STUDIES IN THE ABSORPTION OF FATS

T. F. Zucker. *Proc. Soc. Exp. Biol. and Med.* 17, 89 (1919)

The data of d'Errico could not be reproduced. The absorption of fat directly by the blood is thought unlikely.

574. FAT TRANSPORT IN THE BODY--CHANGES IN THE LIPOID CONTENT OF THE BLOOD AND LYMPH DURING FAT ABSORPTION IN THE DOG

H. C. Eckstein. *Proc. Soc. Exp. Biol. and Med.* 20, 74 (1922)

Total fatty acid and phosphatides of lymph and blood are determined. It is shown that total fatty acids in blood and lymph increase more during the absorption of olive oil than phosphatides.

575. THE DIGESTION AND ABSORPTION OF FAT

J. Mellanby. *J. Physiol.* 64, P5 (1927)

A mixture of neutral fat and bile only, to which lipase had no access, is rapidly absorbed from the duodenum and jejunum and less rapidly from the ileum into the lymphatic system of the small intestine of the cat. Emulsified fat does not require previous hydrolysis for absorption.

576. FAT TRANSPORT THROUGH THE LYMPH SYSTEM IN FASTING AND PHLORIZIN POISONING

H. R. Rony, B. Mortimer and A. C. Ivy. *J. Biol. Chem.* 96, 737 (1932)

The fat content of the thoracic duct lymph of two normal dogs at the height of alimentary lipemia was found ten to twenty times as high as the fat content of the cervical lymph of the same dogs.

577. THE SOURCE OF THE LIPIDS FOUND IN THE THORACIC DUCT LYMPH IN FASTING

H. R. Rony, B. Mortimer and A. C. Ivy. *J. Biol. Chem.* 102, 161 (1933)

The chief source of the lymph fat is the bowel, according to the results of enterectomy experiments. The intestinal mucosa secretes fat into the lumen of the bowel in fasting. A portion of this fat is excreted with the feces and constitutes the endogenous lipid excretion; the major portion of the secreted lipids is hydrolyzed in the lumen of the bowel, reabsorbed into the intestinal mucosa, resynthesized there, and passed into the lacteals.

578. THE LIPID COMPONENTS OF THE LYMPH OF THE THORACIC DUCT OF THE DOG

Susan H. Brockett, Mary A. Spiers and Harold E. Himwich. *Am. J. Physiol.* 110, 342 (1934)

Observations on dogs were made. After fat feeding a great increase in thoracic duct lymph of fatty acids and total cholesterol is noted. Phospholipid phosphorus also increased, but much less so. The portal vein blood does not show any more fatty acids than blood from the femoral vein, nor does the fatty acid content of the blood from either source increase during fat absorption. It is concluded that cholesterol aids in the absorption of fatty acids.

579. THE LIPOIDS OF THE LYMPH OF THE THORACIC DUCT OF DOGS DURING THE ABSORPTION OF NEUTRAL FATS

C. Artom and G. Peretti. *Boll. Soc. Ital. Biol. Sper.* 10, 877 (1935). C. A. 2625 (1936)

Horse fat was administered. Lymph contains + 90% of the fat as glyceric esters with a higher iodine number than the administered fat. Lipoid phosphorus varied greatly, but this is not taken as an indication of phosphoamino lipids. There is more free cholesterol than cholesterol esters.

580. THE LIPOIDS IN THE LYMPH OF THE THORACIC DUCT OF THE DOG DURING ABSORPTION OF NEUTRAL FATS

C. Artom and G. Peretti. *Biochem. e. Terap. Sper.* 23, 249 (1936). C. A. 8333 (1936)

Considerable quantities of horse fat were fed to dogs. The lymph contained the following constituents: small quantities of free fatty acids, oxyacids and soaps, and variable quantities of incompletely saturated glycerides. The average molecular weight of the fatty acids was decreased and the iodine value increased. The free cholesterol was augmented as compared with the esters. Large quantities of phosphorous compounds soluble in organic solvents were present; they did not belong to the phosphoaminolipids proper.

581. AN EXPERIMENTAL REPORT ON THE QUESTION OF FAT RESORPTION OF THE MESENTERIC LYMPH NODES IN SWINE

O. Roemele. *Z. Fleisch- u. Milchhyg.* 48, 241 (1938). C. A. 7551 (1938)

The mesenteric lymph nodes of the milk-fed swine were yellow; the outer parts contained cream, and the inner portions were distended with milk fat. The swine fed on water and beans did not show any of these phenomena. Fat digestion by swine occurs in the small intestine.

582. FAT ABSORPTION AND METABOLISM

A. C. Frazer. *Analyst* 63, 308 (1938). C. A. 5468 (1938)

The experiments show that neutral fat is absorbed by the lacteals and is transported to the depots, whereas fatty acids pass into the portal system and are delivered to the liver.

583. THE IMPORTANCE OF THE LYMPH CIRCULATION IN FAT RESORPTION AS WELL AS IN THE CHANGE OF PERMEABILITY OF CAPILLARIES TOWARDS FAT THROUGH LYMPH OBSTRUCTION

H. Moriki. *Folia Pharmacol. Jap.* 26, 76 (1938). C. A. 2962 (1939)

Experiments on dogs have shown that fat administered by mouth is transported from the intestine chiefly by way of lymphatics, though a part is absorbed directly by blood

capillaries. The absorption by the latter route increases if the lymph vessels are blocked.

584. LYMPHATIC PATHWAYS FROM THE INTESTINE IN THE DOG

L. W. Freeman. *Anat. Rec.* 82, 543 (1942)

In 17 out of 25 experiments lymphatico-venous communications other than the left thoracic duct were found. Cannulation of the thoracic duct within the thorax may insure more adequate collection of intestinal lymph.

(See also Nos. 103, 111, 112, 120, 133, 140, 212, 250, 258, 262, 264, 265, 288, 517, 534, 556, 557, 558, 559, 561, 562, 563, 585, 586, 589, 591 and 594.)

B. Portal Vein

585. ARE THE LACTEALS THE ONLY PATHWAY FOR FAT ABSORPTION?

H. J. Hamburger. *Arch. f. Anat. Physiol.* pg. 554 (1900)

It is shown in dogs that in a part of the intestine of which the lacteals were tied fat absorption occurs to nearly the same extent as in the rest.

586. ABOUT THE PATH OF ABSORPTION OF ALIMENTARY FATS

Gennaro d'Errico. *Arch. di Fisiol.* 4, 513 (1907)

1. Normally and during absorption the solid residue and percentage fat in portal vein blood is greater than in other venous blood.

2. After ligation of the thoracic duct the solid residue of portal vein blood diminishes more than that of jugular vein blood. The percentage of fat decreases in both veins but always stays higher in portal than in jugular vein blood.

3. A thoracic duct fistula decreases the fat and solid residue in portal vein blood less than that of jugular vein blood.

587. ON FAT ABSORPTION AFTER LIGATION OF THE LACTEALS

K. Hall. *Z. Biol.* 62, 448 (1913)

It is found histologically that fat absorption goes on undisturbed in cats when the lacteals were tied.

588. ON THE DETERMINATION OF FAT AND CHOLESTEROL IN ANGIOSTOMIZED DOGS

S. W. Nedswedski. *Arch. Physiol. Pflug.* 214, 337 (1926)

After fat feeding the total fatty acid level in plasma rises; cholesterol is unchanged. Portal vein fat and cholesterol is found higher than that in femoral artery.

It is assumed that fat and cholesterol are partially absorbed by the portal vein.

589. THE BEHAVIOUR OF THE DIFFERENT ORGANS TOWARDS CHOLESTEROL, FAT AND LECITHINS ACCORDING TO EXPERIMENTS ON ANGIOSTOMIZED DOGS

S. W. Nedswedsky and A. K. Alexandry. *Arch. Physiol. Pflug.* 219, 619 (1928)

The fat and cholesterol which are absorbed by way of the portal vein are retained by the liver; the rest go by way of the lymph to the other tissues. The lecithin content of arterial blood is the same in a dog in the postabsorptive as in the actively absorbing dog.

590. W. Sulze. *Ber. Verhandl. Sachs. Akad. Wiss.-Leipzig. Math. Phys. Klasse* 85, 150 (1933). *Ann. Rev. Biochem.* 4, 203 (1935)

Fats, when fed to cats on which the lacteals had been tied off, were almost completely absorbed. The absorptive increase in blood fat was delayed, however, and fat was abundantly deposited in the mesentary and liver.

591. ON THE QUESTION OF PORTAL ABSORPTION OF FAT

S. M. Ling. *Chinese J. Physiol.* 12, 493 (1937)

Thoracic duct lymph of dogs was collected, and then oil was introduced into the duodenum. At the peak of fat absorption (7-8 hours) the fat content of lymph had increased twofold; the portal blood contained + 20% and arterial blood + 15% more fat than during fasting. Neutral fat was increased most, phospholipids and cholesterol less. Thus, it is said, fats are absorbed directly into the blood to an appreciable extent.

592. ON THE PATHWAYS OF ABSORPTION OF FATS AND ON THE QUESTION OF THE ROLE OF THE LUNGS ON LIPID METABOLISM

W. Schrade. *Biochem. Z.* 301, 267 (1939)

Lipid content of blood in right and left sides of heart are compared. No conclusive evidence is presented as to the role of the lungs with regards to changes in blood lipids. Dogs were used.

593. THE DISTRIBUTION OF VITAMINS A AND A₂

J. A. Lovern and R. A. Morton. *Biochem. J.* 33, 330 (1939)

Absorption of fat by fish differs from that of mammals, in that it proceeds directly through the mucosal epithelium and not by a lymphatic system.

594. THE QUESTION OF THE PORTAL ABSORPTION OF FATTY ACIDS

Irwin C. Winter and Lathan A. Crandall, Jr. *J. Biol. Chem.* 140, 97 (1941)

Angiostomy technique on a normal dog is used. Whole blood is extracted according to Majonnier, but lower values are found than when done by Bloor's method for fatty acid and cholesterol.

No significant hepatic inflow-outflow differences in fatty acid content could be demonstrated. A 10% absorption by way of portal route is claimed to be detectable by the methods used.

595. THE TRANSPORTATION OF ABSORBED LIPIDS

J. M. Little and C. S. Robinson. *Am. J. Physiol.* 134, 773 (1941)

Fasted dogs (36-48 hours) were used. It is pointed out that concentration in lymph depends on two variables: 1) quantity of compounds reaching the lymph, and 2) quantity of fluids reaching the lymph.

An increase in lymph phosphatide is related to the rate of fat absorption; 4-17% of the absorbed fat could be recovered in the left thoracic duct lymph. Free cholesterol, neutral fat, and phosphatide concentrations are higher when lipids are absorbed than when non-lipids are absorbed.

596. FAT ABSORPTION IN THE LAYING HEN

R. M. Conrad and H. M. Scott. Poultry Sci. 21, 407 (1942)

Differences in portal and cardiac blood fatty acids content are observe, but the results are very variable. It is proposed, however, that evidence is obtained that much or possibly all the fat is absorbed in the portal circulation rather than in lymph.

(See also Nos. 103, 117, 156, 239, 262, 285, 292, 520, 546, 578, 582 and 583.)

40PC 67-28

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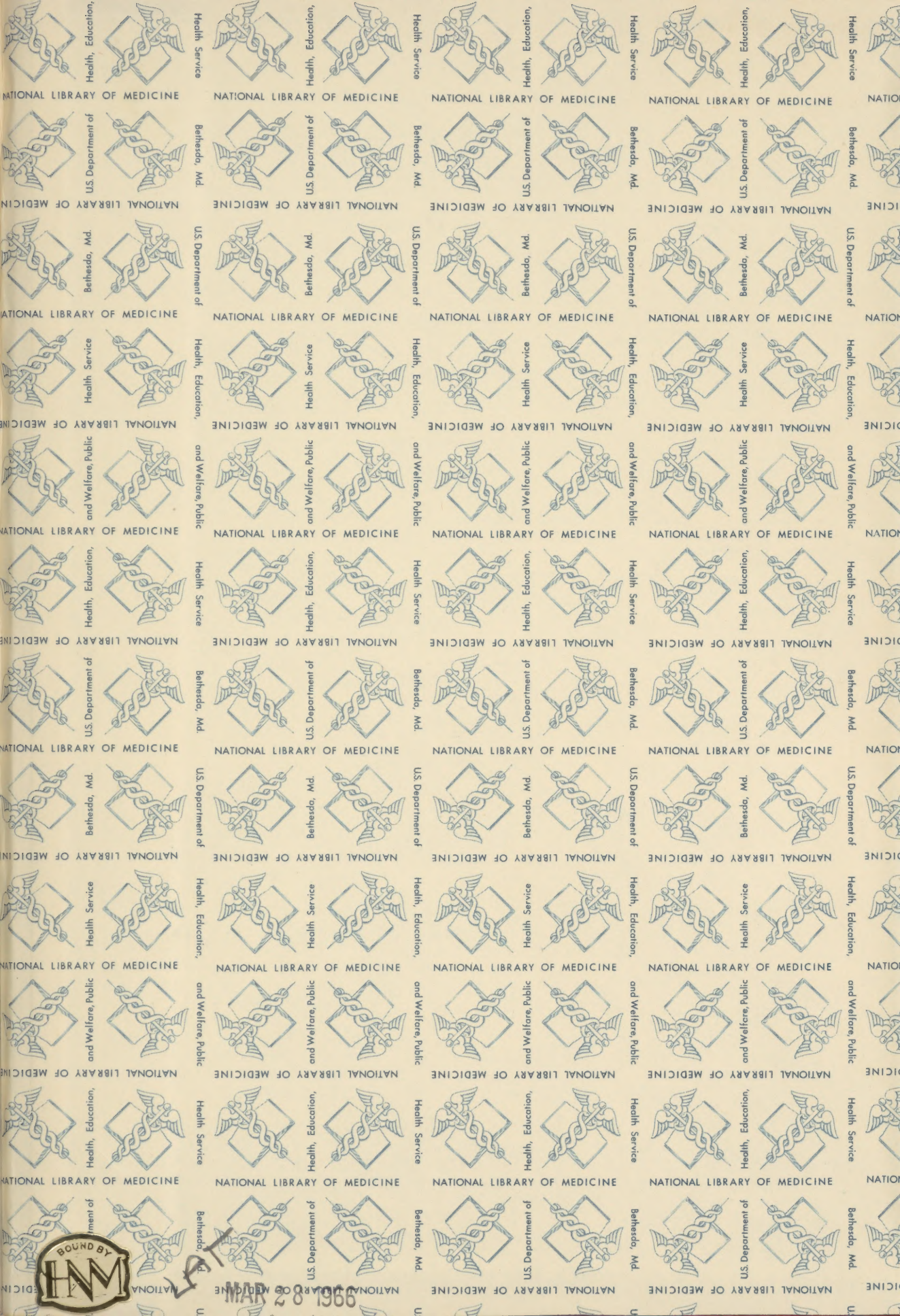
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